

NAVAL POSTGRADUATE SCHOOL

Monterey, California



19971128 038

THESIS

THE ARMY TACTICAL COMMAND
AND
CONTROL SYSTEM

by

Mark A. Huron

June, 1997

Principal Advisor:
Associate Advisor:

Donald van Z. Wadsworth
John H. Gibson

Approved for Public Release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE June 1997	3. REPORT TYPE AND DATES COVERED Master's Thesis
4. TITLE AND SUBTITLE THE ARMY TACTICAL COMMAND AND CONTROL SYSTEM		5. FUNDING NUMBERS
6. AUTHOR(S) Mark A. Huron		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.		
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE
13. ABSTRACT (maximum 200 words)		

This thesis is a summary of the capabilities of the Army Tactical Command and Control System (ATCCS) and the guiding Command, Control, Communications, Computers and Intelligence (C⁴I) documents as they apply to the ATCCS. Its purpose is to strengthen the knowledge base of Army officers entering the Joint C⁴I curriculum by providing a summary of Joint and Army C⁴ doctrine and guidance as it applies to ATCCS.

ATCCS is the Army's primary Command and Control (C²) system at echelons corps and below. ATCCS consists of five smaller systems, each a Battlefield Functional Area Control System (BFACS) controlling seven Battlefield Functional Areas (BFA). The five BFACS are: the Maneuver Control System (MCS), the Advanced Field Artillery Tactical Data System (AFATDS), the Forward Area Air Defense Command, Control and Intelligence System (FAAD C²I), the Combat Service Support Control System (CSSCS), and the All Source Analysis System (ASAS).

A clear strategy for the functional design of ATCCS is supported by three documents. Related to and supportive of each other, the three documents are: Joint Pub 6-0, Doctrine for Command, Control, Communications and Computer Systems Support to Joint Operations; The Army Enterprise Strategy consisting of The Vision and The Implementation Plan; and Army Field Manual 100-5, Operations. This thesis draws threads of continuity from joint doctrine through Army guidance into implementation in ATCCS.

14. SUBJECT TERMS Joint Command, Control, Communications, Computers and Intelligence (C ⁴ I), Command and Control (C ²), The Army Tactical Command and Control System (ATCCS).		15. NUMBER OF PAGES 114	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

Approved for public release; distribution is unlimited.

**THE ARMY TACTICAL
COMMAND AND CONTROL SYSTEM**

Mark A. Huron
Major, United States Army
B.S., Texas A&M University, 1984

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

from the

NAVAL POSTGRADUATE SCHOOL

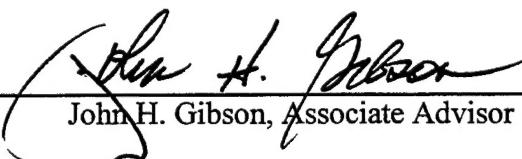
June 1997

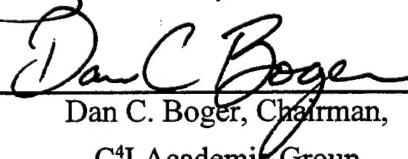
Author:


Mark A. Huron

Approved by:


Donald van Z. Wadsworth, Principal Advisor


John H. Gibson, Associate Advisor


Dan C. Boger, Chairman,
C⁴I Academic Group

ABSTRACT

This thesis is a summary of the capabilities of the Army Tactical Command and Control System (ATCCS) and the guiding Command, Control, Communications, Computers and Intelligence (C⁴I) documents as they apply to the ATCCS. Its purpose is to strengthen the knowledge base of Army officers entering the Joint C⁴I curriculum by providing a summary of Joint and Army C⁴ doctrine and guidance as it applies to ATCCS.

ATCCS is the Army's primary Command and Control (C²) system at echelons corps and below. ATCCS consists of five smaller systems, each a Battlefield Functional Area Control System (BFACS) controlling seven Battlefield Functional Areas (BFA). The five BFACS are: the Maneuver Control System (MCS), the Advanced Field Artillery Tactical Data System (AFATDS), the Forward Area Air Defense Command, Control and Intelligence System (FAAD C²I), the Combat Service Support Control System (CSSCS), and the All Source Analysis System (ASAS).

A clear strategy for the functional design of ATCCS is supported by three documents. Related to and supportive of each other, the three documents are: Joint Pub 6-0, Doctrine for Command, Control, Communications and Computer Systems Support to Joint Operations; The Army Enterprise Strategy consisting of The Vision and The Implementation Plan; and Army Field Manual 100-5, Operations. This thesis draws threads of continuity from joint doctrine through Army guidance into implementation in ATCCS.

TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	BACKGROUND	1
B.	PURPOSE	1
C.	COMMAND AND CONTROL	2
1.	The Lawson Loop	3
a.	<i>Sense</i>	3
b.	<i>Process</i>	4
c.	<i>Compare</i>	5
d.	<i>Decide</i>	5
e.	<i>Act</i>	5
D.	CHAPTER ORGANIZATION	6
E.	SUMMARY	7
II.	JOINT PUB 6-0, DOCTRINE FOR COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTER (C ⁴) SYSTEMS SUPPORT TO JOINT OPERATIONS	9
A.	WHAT IS DOCTRINE?	9
B.	JOINT PUB 6-0	10
1.	The Role of C ⁴ Systems	11
2.	Objectives and Components of C ⁴ Systems	13
a.	<i>Produce Unity of Effort</i>	15
b.	<i>Exploit Total Force Capabilities</i>	15
c.	<i>Properly Position Critical Information</i>	16
d.	<i>Information Fusion</i>	18
3.	The Basic C4 System Principles	18
a.	<i>Interoperable</i>	19
b.	<i>Flexible</i>	20
c.	<i>Responsive</i>	20
d.	<i>Mobile</i>	21
e.	<i>Disciplined</i>	21
f.	<i>Survivable</i>	21
g.	<i>Sustainable</i>	22
C.	SUMMARY	22

III. THE ARMY ENTERPRISE STRATEGY	25
A. FOREWORD	25
B. THE ARMY ENTERPRISE VISION	25
1. The Purpose	27
2. The Threat	28
3. The Principles of The Army Enterprise Strategy	28
a. <i>Focus on the Warfighter</i>	29
b. <i>Ensure Joint Interoperability</i>	31
c. <i>Digitize The Battlefield</i>	32
d. <i>Capitalize on Space Based Systems</i>	33
e. <i>Modernize Power Projection Platforms</i>	35
f. <i>Optimize The Information Technology Environment</i>	35
g. <i>Implement Multi-Level Security</i>	36
h. <i>Ensure Spectrum Superiority</i>	36
i. <i>Acquire Integrated Systems Using Commercial Technology</i> ..	37
j. <i>Exploit Modeling and Simulation</i>	38
C. THE ARMY ENTERPRISE IMPLEMENTATION PLAN	38
1. The Purpose	39
a. <i>Assessment of Existing Systems</i>	39
b. <i>The Investment Strategy For The Future</i>	41
c. <i>The Action Plan</i>	41
D. SUMMARY	42
IV. ARMY OPERATIONS	45
A. COMBAT POWER	45
1. The Elements of Combat Power	46
a. <i>Maneuver</i>	46
b. <i>Firepower</i>	47
c. <i>Protection</i>	47
d. <i>Leadership</i>	48
2. The Combat Functions	49
a. <i>Intelligence</i>	49
b. <i>Maneuver</i>	50
c. <i>Fire Support</i>	50
d. <i>Air Defense</i>	50
e. <i>Mobility and Survivability</i>	51

f. <i>Logistics</i>	51
g. <i>Battle Command</i>	52
B. SUMMARY	53
V. THE ARMY TACTICAL COMMAND AND CONTROL SYSTEM	55
A. THE COMPONENTS OF ATCCS	55
B. COMMON HARDWARE AND SOFTWARE	57
C. THE COMMUNICATIONS HUB	58
1. The Army Data Distribution System (ADDS)	59
a. <i>EPLRS</i>	59
b. <i>JTIDS</i>	60
2. The Combat Net Radios (CNR)	60
3. The Area Common User System (ACUS)	61
D. THE BATTLEFIELD FUNCTIONAL CONTROL SYSTEMS	62
1. The All Source Analysis System (ASAS)	62
2. The Maneuver Control System (MCS)	62
3. The Advanced Field Artillery Tactical Data System (AFATDS)	63
4. The Forward Area Air Defense Command, Control, and Intelligence System (FAAD C ² I)	64
5. The Combat Service Support Control System (CSSCS)	65
E. SUMMARY	66
VI. THE THREADS OF CONTINUITY	69
A. COMMON THREADS IN TONE	69
B. COMMON THREADS IN OBJECTIVE	71
1. Focus On The Warfighter	71
2. Ensure Joint Interoperability	72
3. Digitize The Battlefield	72
4. Capitalize On Space Based Systems	73
5. Modernize Power Projection Platforms	73
6. Implement Multi-Level Security	73
7. Ensure Spectrum Supremacy	74
C. COMMON THREADS IN GUIDANCE	74

1.	Interoperable	75
2.	Flexible	77
3.	Responsive	79
4.	Mobile	81
5.	Disciplined	82
6.	Survivable	83
7.	Sustainable	84
D. SUMMARY		86
LIST OF REFERENCES		89
APPENDIX A. GLOSSARY OF TERMS		91
APPENDIX B. ACRONYMS AND ABBREVIATIONS		93
INITIAL DISTRIBUTION LIST		103

EXECUTIVE SUMMARY

The purpose of this thesis is to strengthen the knowledge base of Army officers entering the Joint C⁴I curriculum by providing a summary of the capabilities of the Army Tactical Command and Control System (ATCCS) and the guiding Command, Control, Communications, Computers and Intelligence (C⁴I) documents as they apply to ATCCS.

Command and control is a process whereby commanders use personnel, equipment, communications, facilities and procedures (*command and control systems*) to plan, organize, direct, coordinate, and control (*command or control*) their subordinates. The Lawson Loop is an accepted model of the command and control process. Developed by Joel S. Lawson, it is considered applicable to C² processes ranging from the Napoleonic era to the 1990s [Ref. 2]. The model consists of five functions: Sense, Process, Compare, Decide, and Act. The Lawson Loop is an iterative process whereby commanders on both sides are constantly executing the loop. As a commander on one side acts, in theory, it is sensed by the commander on the other side, who then begins an iteration of the loop. Again, in theory, the commander who can iterate the loop with the most speed and accuracy will act faster than the enemy can respond to, thereby dominating the opposition. This is called "getting inside" the enemy's decision cycle [Ref. 2]. Understanding the Lawson Loop allows the reader to recognize the importance of C⁴I doctrine and systems that facilitate the command and control process of sensing, processing, comparing, deciding, and acting.

Doctrine serves as authoritative guidance to commanders. It is intended to guide, but not bound actions while conducting the full range of military operations. At the joint level,

doctrine for the C⁴I community exists in Joint Pub 6-0. It is the keystone document for the command, control, communications, and computer (C⁴) systems series of publications [Ref. 4]. As an all encompassing document, Joint Pub 6-0 covers all facets of C⁴ systems support to joint operations. Major topics discussed in this thesis are:

- The role of C⁴ systems.
- Objectives and components of C⁴ systems.
- The basic C⁴ system principles.

Discussion of these three topics shows how the role, objectives and principles of C⁴ systems relate to each other and support the C⁴I For The Warrior Vision. Understanding these three areas of C⁴ doctrine at the highest level allows the reader to understand the impetus behind the Army's Enterprise Strategy.

At the Army level, The Army Enterprise Strategy is the keystone document outlining principles and the implementation plan for Army C⁴ systems support to operations. The strategy is "...the single, unified vision for the Army C⁴I community." [Ref. 6] The Strategy consists of two documents: *The Army Enterprise Vision* and *The Army Enterprise Implementation Plan*. *The Army Enterprise Vision* introduces ten principles vital to ensuring information dominance for the warrior. *The Army Enterprise Implementation Plan* outlines steps the Army must take to fulfill the vision. The guidance found in The Army Enterprise Strategy falls under the authority of joint doctrine and supports it with common principles. Understanding that there are threads of continuity that start at joint doctrine and flow through Army guidance sets the doctrinal foundation for the design, development and procurement of Army C⁴ systems such as ATCCS.

ATCCS is the Army's primary Command and Control (C²) system at echelons corps and below. A clear strategy for the functional design of ATCCS is supported by Joint Pub 6-0, The Army Enterprise Strategy, and Army Field Manual 100-5, Operations. ATCCS is an overarching command and control system comprised of subordinate Battlefield Functional Area Control Systems (BFACS). The Army uses the BFACS to control seven Battlefield Operating Systems (BOS) essential to sustaining combat power. The Intelligence BOS is controlled by the All Source Analysis System (ASAS), the Maneuver BOS is controlled by the Maneuver Control System (MCS), the Fire Support BOS is controlled by the Advanced Field Artillery Tactical Data System (AFATDS), the Air Defense BOS is controlled by the Forward Area Air Defense Command, Control and Intelligence System (FAAD C²I), and the Logistics BOS is controlled by the Combat Service Support Command and Control System (CSSCS). The other two BOSs, Mobility and Survivability, and Battle Command are integrated into the other five. Since Mobility and Survivability enhances maneuver, that is where it is controlled; in the Maneuver Control System. As the overarching BOS, Battle Command, is the function that integrates and synchronizes the other six. The ATCCS integrates and synchronizes the other BFACS. It represents the Battle Command combat function. Understanding how doctrine and guidance affect the functional design and capabilities of the Army Tactical Command and Control System provides the information base for identifying threads of continuity from joint doctrine through Army doctrine and into implementation in the Army Tactical Command and Control System.

Some of the threads of continuity are clearly identifiable in the text of joint and Army doctrine and others are more abstract but, none the less, there. The author categorizes and

identifies three types of threads:

- Common Threads in Tone. This section validates that the guiding C⁴I documents discussed in this thesis are written in a tone commensurate with the definition of doctrine.
- Common Threads in Objective. This section shows the reader how the fundamental objective of C⁴ systems outlined at the joint level is *also* supported by principles at the next lower level: The Enterprise Strategy Principles.
- Common Threads in Guidance. This section validates that principles outlined at the joint level are carried through the Army level, and that there is evidence of implementation of those principles in ATCCS.

Understanding the threads of continuity accomplishes the purpose of this thesis.

I. INTRODUCTION

This introductory chapter outlines this thesis. It states the background and purpose of this thesis. It also introduces the reader to command and control by defining terms associated with command and control, showing how the definitions are interrelated, and explaining the command and control process. Finally, this chapter outlines the information found in the remaining chapters.

A. BACKGROUND

The background leading to this study is based on the author's interviews with Army officers entering the Joint Command, Control, Communications, Computers, and Intelligence (C⁴I) Curriculum at the Naval Postgraduate School; sections JC-51, JC-61 and JC-71. Officers from those sections reported having little or no knowledge regarding guiding C⁴I documents or current Army C⁴I systems. This is a function of how and when the Army selects its officers for Advanced Civil Schooling and is unrelated to the thesis itself. The current Joint C⁴I Curriculum is thorough, however, it starts at a point beyond the C⁴I knowledge base of an incoming Army officer.

B. PURPOSE

The purpose of this thesis is to supplement the Joint C⁴I Curriculum by strengthening the C⁴I knowledge base of Army officers entering the curriculum. It will do so by providing a concise summary of Joint doctrine, Army C⁴I guidance, and Army operational doctrine as they relate to an Army C⁴I system; the Army Tactical Command and Control System (ATCCS). As a final step to accomplishing the purpose of the thesis, the author will show

where there is evidence of joint doctrine and Army guidance implementation in ATCCS.

This text excludes the engineering behind the capabilities because the Joint C⁴I curriculum accomplishes that. This thesis may also serve as a reference for officers from other services.

C. COMMAND AND CONTROL (C²)

In order to understand the purpose and functions of C⁴I systems, it is important to understand what command and control is, what a command and control system is and what the terms mean separately in a military context. Several authors paraphrase definitions and all are relatively the same. The authoritative definitions exist in Joint Pub 1.02:

Command. The authority that a commander in the Armed Forces lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. [Ref. 1]

Control. Authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations [Ref. 1].

Command and Control System. The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned [Ref. 1].

Command and Control. The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. [Ref. 1]

The definitions are clearly interrelated and build on each other. There are three concepts to understand after reading these definitions:

- *Command and control*, separately, both refer to commanders' authority over subordinates. It involves planning, organizing, directing, coordinating, and controlling the forces under their *command* or *control*.
- A *command and control system* includes personnel, equipment, communications, facilities and procedures that facilitate commanders' ability to *command* or *control*.
- Command and control, together, is a process, a process whereby the commanders use personnel, equipment, communications, facilities and procedures (*command and control systems*) to plan, organize, direct, coordinate, and control (*command or control*) their subordinates.

A firm understanding of the relationships between the definitions above will help the reader progress through this thesis and the Joint C⁴I curriculum.

1. The Lawson Loop

The last definition above describes command and control as a process. The Lawson Loop in Figure 1 is an accepted model of the command and control process. Developed by Joel S. Lawson, it is considered applicable to C² processes ranging from the Napoleonic era to the 1990s [Ref. 2]. The model consists of five functions; they are:

- Sense
- Process
- Compare
- Decide
- Act

a. *Sense*

Refer to Figure 1; the sense function collects data from the environment. The commander uses all available assets to include intelligence gathered by soldiers, radar, and

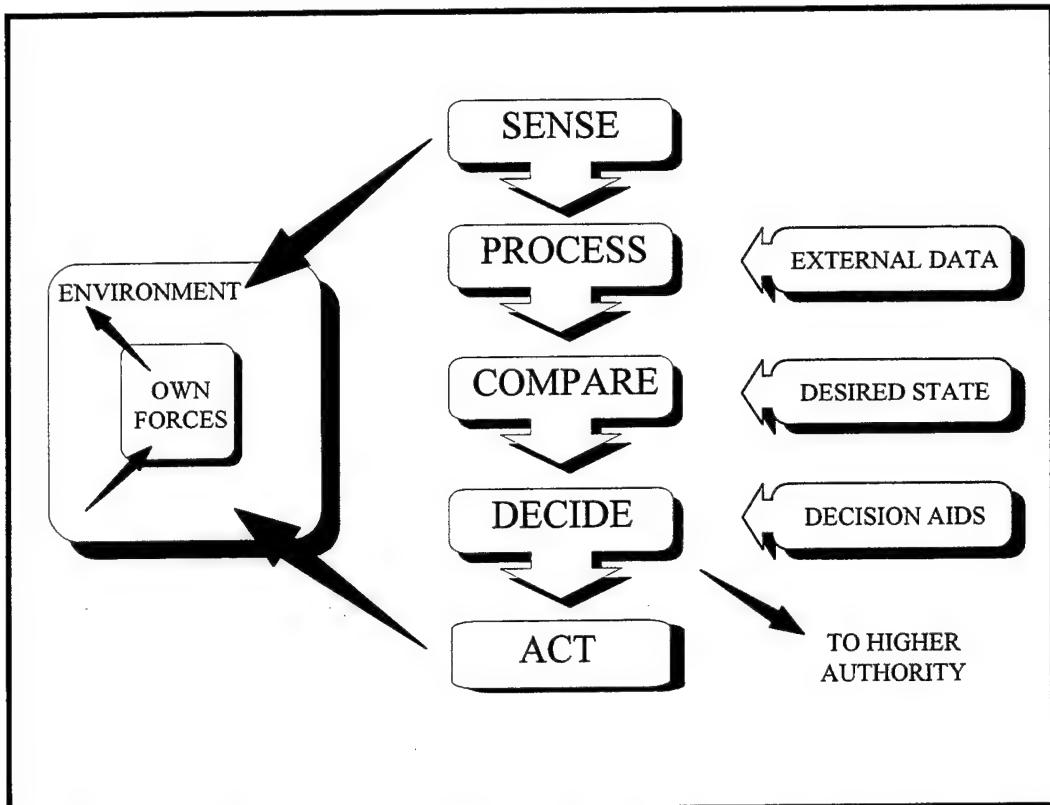


Figure 1. The Lawson Command and Control Loop. After Ref. [2].

unmanned aerial vehicles ... The environment includes friendly and enemy forces, terrain, weather and other information valuable to commanders. [Ref. 2]

b. Process

The process function pulls together and correlates the data gathered from the sense function. Though the Lawson Loop function called "process" is a common term in used in the information management community, the military C⁴I community calls this function data fusion. The definition of fusion given in Joint Pub 1.02 is:

In intelligence usage, the process of examining all sources of information and intelligence to derive a complete assessment of activity [Ref. 1].

c. Compare

The commander takes the information just processed in the process function and compares the current state of the environment to the desired state of the environment. The current state may indicate enemy strong and weak points, disposition, and intent. The commander's staff will probably develop courses of action to move the current state of the environment toward the desired state. [Ref. 2]

d. Decide

Following the compare function, commanders decide from the courses of action presented by their staff. This function may seem a small part of a large process, but in reality is a thorough process whereby a commander examines and contrasts the available courses of action for viability and effect. In some cases, the commander may reject all or part of courses of action requiring more planning by the staff. Additionally, the commanders will report their intended decision and subsequent action to higher headquarters; this too may affect rejection or modification of courses of action.

e. Act

The act function is the manifestation of the commander's decision. The commander issues orders to affect the current state of the environment. [Ref. 2]

The Lawson Loop is an iterative process whereby commanders on both sides are constantly executing the loop. As a commander on one side acts, in theory, it is sensed by the commander on the other side, who then begins an iteration of the loop. Again, in theory, the commander who can iterate the loop with the most speed and accuracy will act faster than the enemy can respond to thereby dominating the opposition. This is called

“getting inside” the enemy’s decision cycle [Ref. 2]. Understanding the Lawson Loop allows the reader to recognize the importance of C⁴I doctrine and systems that facilitate the command and control process of sensing, processing, comparing, deciding, and acting. With respect to security, a command and control system that is easily violated will inevitably hinder the ability of a commander to iterate the C² process quickly.

D. CHAPTER ORGANIZATION

Chapters II and III provide a summary of the guidelines and principles for the design, capabilities and implementation of command and control systems such as ATCCS. Each of the chapters corresponds to a document that affects ATCCS. The two documents are: Joint Pub 6-0, Doctrine for Command, Control, Communications and Computer Systems Support to Joint Operations; and The Army Enterprise Strategy consisting of The Vision and The Implementation. In the chapters are explanations of how the documents relate to and support each other as well as how they relate to the Army Tactical Command and Control System. They represent C⁴I guidance from the Joint Chiefs of Staff level down to the Army level.

Chapter IV summarizes portions of Army Field Manual 100-5, Operations; the Army’s keystone warfighting document [Ref. 3]. In that summary is an overview of how the Army fights at the task force level focusing on integration of seven Battlefield Functional Areas (BFA): intelligence, maneuver, fire support, air defense, mobility and survivability, logistics, and battle command. This chapter provides some insight for why the ATCCS consists of five smaller systems; each a Battlefield Functional Area Control System (BFACS) controlling the seven BFAs.

Chapters V provides an overview of the capabilities of ATCCS as well as the

individual capabilities of the five BFACS. It also outlines the systems and capabilities of the Communications Hub of ATCCS, and familiarizes the reader with the Common Hardware and Software Concept that supports ATCCS.

Finally, Chapter VI discusses the threads of continuity that flow from joint publications through Army publications and into implementation in the Army Tactical Command and Control System.

E. SUMMARY

This chapter provides the background and purpose of this study. It is the outline for how the thesis is structured. The chapter introduces the doctrinal definitions of command, control, command and control, and command and control system to prepare the reader for concepts discussed in later chapters. Finally, this chapter provides an overview of the remaining chapters by summarizing their content.

II. JOINT PUB 6-0, DOCTRINE FOR COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTER (C⁴) SYSTEMS SUPPORT TO JOINT OPERATIONS

A. WHAT IS DOCTRINE?

In the United States Army, doctrine serves as authoritative guidance to commanders. It is intended to guide, but not bound actions while conducting the full range of military operations. This concept is clear in the definition of doctrine given in Army Field Manual 100-5, Operations:

Fundamental principles by which military forces guide their actions in support of national objectives. Doctrine is authoritative but requires judgement in application. [Ref. 3]

The last sentence of this definition is important; it says "guide, not bound". Given the wide range of military operations and threats that face today's commanders, this concept is more important now than ever. The commanders *on the ground*, must have the authority to prosecute their mission to ensure victory. This includes how commanders organize their forces and equipment to include C⁴I systems in support of military operations. Joint doctrine, in concept, is no different. It "...will be followed except when, in the judgement of the commander, exceptional circumstances dictate otherwise." [Ref. 4] Joint doctrine, also, is intended to be authoritative, but not restrictive and exists for the wide range of organizational structures that commanders may find themselves under. Again, the authoritative definitions exist in Joint Pub 1.02:

Doctrine. Fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgement in application. [Ref. 1]

Combined Doctrine. Fundamental principles that guide the employment of forces of two or more nations in coordinated action toward a common objective. It is ratified by participating nations. [Ref. 1]

Joint Doctrine. Fundamental principles that guide the employment of forces of two or more Services in coordinated action toward a common objective. It will be promulgated the Chairman of the Joint Chiefs of Staff, in coordination with the combatant commands, Services, and Joint Staff. [Ref. 1]

Multi-Service Doctrine. Fundamental principles that guide the employment of forces of two or more Services in coordinated action toward a common objective. It is ratified by two or more Services, and is promulgated in multi-Service publications that identify the participating Services, e.g. Army-Navy doctrine. [Ref. 1]

These definitions are only separated by the organizational structure they apply to. There are three concepts to understand after reading these definitions:

- The term "...fundamental principles...that guide their actions...." exists in every definition. This is the essence of doctrine that makes it the cornerstone for how the Services fight alone and together. Although the definitions above apply to doctrine with respect to organizational structure, it can apply to all areas of the military to include how the Services prepare for and plan the execution of war.
- Doctrine provides a common approach to operations for those it applies to [Ref. 3].
- The sentence "It is authoritative but requires judgement in application." from the first definition of doctrine is implied in the definitions of combined, joint and multi-Service doctrine.

Understanding these concepts will help the reader understand how the guidelines and principles in Joint Pub 6-0, The Enterprise Strategy and Army Field Manual 100-5 effect the design and implementation of the Army Tactical Command and Control System.

B. JOINT PUB 6-0

Joint Pub 6-0 is the keystone document for the command, control, communications,

and computer (C⁴) systems series of publications [Ref. 4]. It is based on The C⁴I For The Warrior Vision:

What the Warrior Needs: a fused, real time, true representation of the battlespace - an ability to order, respond and coordinate horizontally and vertically to the degree necessary to prosecute his mission in that battlespace. [Ref. 4]

As an all encompassing document, Joint Pub 6-0 is joint doctrine covering all facets of C⁴ systems support to joint operations. Major topics covered are:

- The role of C⁴ systems.
- Objectives and components of C⁴ systems.
- The basic C⁴ system principles.
- C⁴ system configurations.
- The planning process and employment responsibilities.
- Joint and combined standardization.
- Global C⁴ infrastructure.

Although all these topics are important, the purpose of this thesis limits discussion of the first three topics only. Later chapters discuss how these topics relate to the Army Tactical Command and Control System and the reader is encouraged to read the entire Joint Pub 6-0 for a fuller understanding of C⁴ systems support to joint operations.

1. The Role Of C⁴ Systems

C⁴ systems must meet a commander's information needs by facilitating the processing and flow of quality data; this, in essence, is the role of C⁴ systems [Ref. 4]. This role gains importance today because the Armed Forces are smaller and less able to

overwhelm by mass. Though smaller in size, our Armed Forces must still overwhelm and achieve decisive victory. The trend towards high-tech equipment and information availability allows commanders to still overwhelm despite a smaller force. They achieve this by better application of their force.

Technology incorporated into today's war fighting equipment requires complex command and control systems. Modern weapon delivery systems match speed with high mobility, precision, lethality and stealth. These weapon features combined with the ability to mass critical information on the enemy produces violent results. A single weapon system can engage and destroy many targets with less ordnance thereby increasing the pace of combat. While a fast pace allows commanders to overwhelm the enemy and maintain the initiative, it also challenges commanders by presenting more options and opportunities in combat. In the absence of sophisticated C⁴ systems for management and control, it is likely that some of these options and opportunities will be missed [Ref. 5]. Commanders must have "...a fused, real time, true representation of the battlespace...." [Ref. 4] to offset the complexity of today's high tech, fast paced warfare.

Another trend increasing the importance of the role of C⁴ systems is the worldwide proliferation of information systems and the information they provide. This information proliferation trend can lead to information overload. The role of C⁴ systems addresses information overload by limiting the role to the processing of "quality information." Joint Pub 6-0 provides a guide for what quality information is (Figure 2). Commanders need the *right* information, not the *most* information, to be effective decisionmakers. This is not to say that quality information will always lead to the right decision; it only helps. Quality

INFORMATION QUALITY CRITERIA

1. ACCURACY. Information that conveys the true situation.	displays.
2. RELEVANCE. Information that applies to the mission, task, or situation at hand.	5. COMPLETENESS. All necessary information required by the decisionmaker.
3. TIMELINESS. Information that is available in time to make decisions.	6. BREVITY. Information that has only the level of detail required.
4. USABILITY. Information that is in common, easily understood format and	7. SECURITY. Information that has been afforded adequate protection where required.

Figure 2. Information Quality Criteria. After Ref. [4].

information cannot compensate for poor human judgement [Ref. 3]. Quality information can, however, help reduce the uncertainty commanders must deal with when making decisions in combat.

2. Objectives and Components of C⁴ Systems

The fundamental objective of C⁴ systems is to get the critical and relevant information to the right place at the right time [Ref. 4]. Two key words in the fundamental objective that cannot be overlooked are *critical* and *relevant*. Because of the vast amount of information available, it is easy to overwhelm commanders with information that they do not want or do not need (*information overload*). Relevant information is defined in Figure 2, Information Quality Criteria, but critical information is often difficult to discern; it is best defined by the commander. A commander influences what critical information is collected and processed by identifying what information they must have to ensure enemy failure or acceptable friendly consequences [Ref. 1].

Within the fundamental objective are four specific objectives; a C⁴ system that meets

these objectives helps a commander plan, direct, coordinate and control (*command and control*) their forces. The four objectives are:

- Produce Unity of Effort.
- Exploit Total Force Capabilities.
- Properly Position Critical Information.
- Information Fusion.

These four specific objectives focus the type of information provided to commanders. For the purpose of this thesis, it is important to understand that a C⁴ system meeting these objectives affects a commander's ability to employ Army operational doctrine found in the Principles of War (Figure 3).

PRINCIPLES OF WAR	
1. OBJECTIVE.	Direct every military operation toward a clearly defined, decisive and obtainable objective.
2. OFFENSIVE.	Seize, retain, and exploit the initiative.
3. MASS.	Mass the effects of overwhelming combat power at the decisive place and time.
4. ECONOMY OF FORCE.	Employ all combat power available in the most effective way possible; allocate minimum essential combat power to secondary efforts.
5. MANEUVER.	Place the enemy in a position of disadvantage through the flexible application of combat power.
6. UNITY OF COMMAND.	For every objective, seek unity of command and unity of effort.
7. SECURITY.	Never permit the enemy to acquire unexpected advantage.
8. SURPRISE.	Strike the enemy at a time or place or in a manner for which he is unprepared.
9. SIMPLICITY.	Prepare clear, uncomplicated plans and concise orders to ensure thorough understanding.

Figure 3. The Principles of War [Ref. 3].

a. *Produce Unity of Effort*

A C⁴ system that facilitates unity of effort provides information that focuses all military efforts on the common objective. Joint Pub 6-0 explains Unity of Effort with respect to C⁴ systems:

C⁴ systems should help a military force and its supporting elements to combine the thoughts and impressions of multiple commanders and key warfighters to allow the views of many experts to be brought to bear on any given task [Ref. 4].

The Principles of War list unity of effort under the sixth Principle of War, Unity of Command. This is because unity of command is the first step to achieving unity of effort. Unity of command means giving command of all forces seeking a common objective to one responsible commander. Unity of command is a tangible concept and allows for a single commander's intent; the commander's vision of the desired end state of the mission. Unity of effort, however, is less tangible, but complements unity of command. Unity of effort means cooperation and coordination among the forces under the single commander in order to achieve the common objective. It's goal is to unite the actions of subordinate commanders; unity of effort may cross command lines, but is always focused on the objective. Only actions that support achieving the objective produce unity of effort, and so, only a C⁴ system that provides information that is *critical* and *relevant* to achieving the objective will help commanders achieve *unity of effort*.

b. *Exploit Total Force Capabilities*

Joint Pub 6-0 explains the second specific objective of C⁴ systems:

C⁴ systems must be planned as extensions of human senses and processes to help the commanders form perceptions, make

decisions, and react. This allows commanders to be effective during high-tempo operations. [Ref. 4]

A C⁴ system that achieves this objective helps commanders apply the principles of mass, maneuver, surprise and economy of force. It will bring real-time information from the five Battlefield Functional Areas together so that commanders know the disposition and employment of the enemy. A C⁴ system that provides real-time information gives commanders a distinct advantage over the enemy. It allows them to mass fires from direct and indirect weapons, maneuver to defeat the enemy based on their orientation, and apply economy of force where necessary. Our commanders can fight smarter with fewer casualties because they know what the enemy is doing shortly after they do it.

c. Properly Position Critical Information

Joint Pub 6-0 says:

C⁴ systems must be able to respond quickly to requests for information and to place and maintain that information where it is needed [Ref. 4].

The ability to do this depends on the functions and components of C⁴ systems. Proper configuration of the components and adherence to the C⁴ Principles (to be discussed later) achieves this C⁴ objective. Properly positioning critical information involves the basic transport of information and affects a commander's ability to apply all the principles of war. Joint Pub 6-0 defines information as "...data collected from the environment and processed into a usable form....". Putting that information into a usable form requires C⁴ systems to support the following five functions:

- Collect. Acquiring or gathering and initial filtering of information based on a planned need and time sensitivity. Collection also involves putting the information into a form suitable for transport. [Ref. 4]
- Transport. Moving information between processing devices [Ref. 4].
- Process. Storing, recalling, manipulating, filtering and fusion of data to produce the minimum essential information in a usable form for the warfighter [Ref. 4].
- Disseminate. Distributing processed information to the appropriate users [Ref. 4].
- Protect. Ensuring the secure flow and processing of information and access only by authorized personnel [Ref. 4].

The components of C⁴ systems that execute the functions are:

- Terminal Devices. Items such as telephones, faxes and computers that turn voice, data, imagery or messages into a format for electronic transmission [Ref. 4].
- Transmission Media. Mediums such as freewave (e.g. radio and space based systems), metallic wire or fiber-optic cable that connect terminal devices [Ref. 4].
- Switches. Devices that route voice, data, imagery or messages through networks of transmission media. Circuit switches typically route telephone traffic through a dedicated connection. Packet and message switches typically route pieces of the same data/message through many different routes; the data/message is broken into pieces/packets at the sending location and is then assembled at the destination. [Ref. 4]
- Networks. Terminal Devices and Transmission Media connected by Switches to transport information to its destination [Ref. 4]. Computers are the most common terminal device found in networks.
- Control. Control provides management of Networks. Network Control manages area, regional, theater or global networks while Nodal Control manages smaller areas such as command centers [Ref. 4].

- An example of the components of C⁴ systems in a basic communications system configuration is depicted in Figure 4.

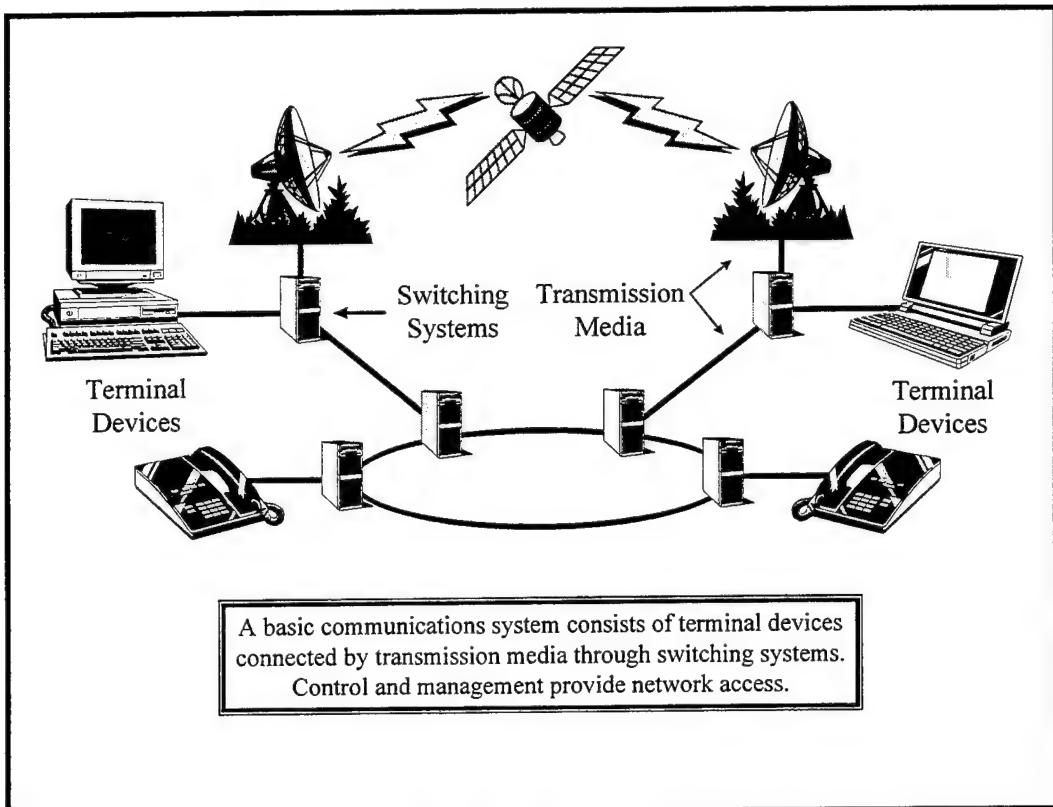


Figure 4. Basic Communications System. After Ref. [4].

d. Information Fusion

Information fusion, is the ability to compile data from many different sources to give an integrated representation of the battlefield. Information fusion is usually accomplished at a fusion center where intelligence experts analyze all available information from the different sources to give a complete assessment of activity [Ref. 1]. This objective is all encompassing in that it allows a commander to get a complete picture based on current information. As with objective three, it depends on proper configuration of the C⁴ components and adherence to the C⁴ Principles.

3. The Basic C⁴ System Principles

Up to this point, discussion is centered around getting the *right information* to the

right person at the right time. This single statement sums-up the essence of the C⁴I For the Warrior Vision. The Basic C⁴ System Principles address the concept that getting the right information to the right person at the right time involves *continuous* and *uninterrupted* flow and processing of information. The vision cannot become reality if the information is not accessible at all times. These principles ensure accessibility of information in an Armed Forces that traditionally procures equipment by Service, but must fight jointly. The Basic C⁴ System Principles say that C⁴ systems must be:

- Interoperable
- Flexible
- Responsive
- Mobile
- Disciplined
- Survivable
- Sustainable

*a. **Interoperable***

Joint and Service C⁴ systems must possess the interoperability necessary to ensure mission success in joint and combined operations. Interoperability is the condition achieved among C⁴ systems or items of C⁴ equipment when information or services can be exchanged directly and satisfactorily between them and their users [Ref. 4]. Joint Pub 6-0 is clear in saying that information must pass *directly* and *satisfactorily* between systems. This means systems must transfer information without any intermediate processing and the information must be usable when received. To promote interoperability, there are the

concepts of:

- Commonality. Equipment is common when personnel trained on other (similar) equipment can operate and maintain it with no additional specialized training. Commonality also means interchangeability of repair parts and consumable items. [Ref. 4]
- Compatibility. Equipment is compatible when two or more systems can operate in the same environment without interfering with each other. [Ref. 4]
- Standardization. Equipment is standardized when it includes aspects of commonality, compatibility and interoperability. Although operational requirements of Services may limit equipment in size, weight or other physical characteristics, standardization achieves the closest possible cooperation among the Services to maximize the number of features of commonality, compatibility and interoperability. This means common or compatible technical procedures and common, compatible or interchangeable supplies and parts. With respect to data, it includes standard graphics formats and information transfer protocols. [Ref. 4]

b. Flexible

Flexibility is the concept whereby C⁴ systems are designed and operate in a way that allows for rapid integration of equipment between separate units. Flexibility is necessary in joint operations because the organizational structure of a joint force is not standardized. Flexibility is achieved through the use of standardized design, commercial off the shelf (COTS) components and standards, commercial facilities, mobile and transportable systems, and pre-positioned facilities [Ref. 4].

c. Responsive

Recalling that the C⁴I For the Warrior Vision calls for "...fused, real time, true representation of the battlespace....", it is implied that information must come *on demand*. In order for C⁴ systems to achieve this, they must be responsive. Responsive systems must

be:

- Reliable. C⁴ systems must be available when needed and must perform as intended [Ref. 4].
- Redundant. Redundancy provides for alternate paths, back-up systems, and equipment that recover communications quickly in the event of failure [Ref. 4].
- Timely. The processing and transmission time for warning, critical intelligence, and operation order execution information is minimized [Ref. 4].

d. Mobile

Mobile systems are physically designed to compliment the mobility of the forces they support. There should be no degradation in performance as a result of size, weight or other physical limitations. [Ref. 4]

e. Disciplined

A disciplined system is less a function of system design and more an issue of asset management. C⁴ systems possess finite capabilities and are a limited resource on the battlefield. It is, therefore, important that commanders manage and control the flow and processing of information as well as the C⁴ assets themselves. Additionally, commanders must prioritize information. This prevents information overload or system degradation due to excessive information flow. Finally, commanders must manage the frequencies along functional lines (e.g. admin, logistics, operational) and in accordance with international and host nation communication laws.

f. Survivable

- Since C⁴ systems are the lifeblood of command centers, it only makes sense

that they must be survivable. However, they must only be as survivable as the command center they support. This makes economic sense and is achieved by employing the full range of security measures. Techniques include physical security measures such as dispersal of facilities, multiple network nodes, hardening of equipment and facilities, personnel access rosters, operations security measures (OPSEC), communications security measures (COMSEC), or a combination of these. Other techniques include software protection measures such as user access controls (passwords), intrusion detection software, viral detection software, or a combination of these. Finally, survivability involves measures to recover information and communications in the event of intrusion or system failure.

g. *Sustainable*

The final Basic C⁴ Principle anchors the principles themselves. Sustainability, in this context, means “continuous support during any type and length of joint operation.” [Ref. 4] It is the single principle that specifically addresses *continuous* and *uninterrupted* flow and processing of information; the specified focus of the principles. Inherent in sustainment operations is the training and employment of maintenance personnel and system operators as well as other system-specific logistics requirements like spare parts and expendable supplies. A C⁴ system that has the attributes of all the other principles, but lacks sustainability, defeats the purpose of the principles as a whole.

C. SUMMARY

This chapter provided an overview of the top level doctrine governing C⁴ systems support to joint operations; Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C⁴) Systems Support to Joint Operations. It provided the reader with the

basic doctrine governing the purpose and design of C⁴ systems. It defined doctrine focusing on the concept that doctrine is intended to guide, not limit the commander's initiative in the prosecution of their mission. That definition sets the foundation for discussion of the role of C⁴ systems, the objectives and components of C⁴ systems, and the Basic C⁴ Principles for design of C⁴ systems. It is a sequenced approach showing how the role, objectives and principles of C⁴ systems relate to each other and support the C⁴I For The Warrior Vision.

Understanding these three areas of C⁴ doctrine at the highest level allows the reader to understand the impetus behind the Army's Enterprise Strategy, discussed in the next chapter. It also allows the author to show joint doctrine's influence on the Enterprise Strategy. This chapter is the first step in showing what documents govern and influence the functional design of the Army Tactical Command and Control System.

III. THE ARMY ENTERPRISE STRATEGY

The previous chapter outlined the top-level doctrine governing C⁴ systems support to joint operations: Joint Pub 6-0. It was a sequenced approach showing how the role, objectives and principles of C⁴ systems relate to each other and support the C⁴I For The Warrior Vision at the Joint level. This chapter introduces the reader to The Army Enterprise Strategy; the Army's unified vision for the Army C⁴I community [Ref. 6]. The purpose of this chapter is to show the reader how The Army Enterprise Strategy falls under the authority of joint doctrine, namely Joint Pub 6-0. In achieving the purpose, this chapter will also identify where the doctrine of Army Field Manual 100-5, Operations, influences The Army Enterprise Strategy.

A. FOREWORD

Just as Joint Pub 6-0 is the keystone document covering C⁴ systems support to joint operations, The Army Enterprise Strategy is a keystone document outlining principles and the implementation plan for Army C⁴ systems support to operations. The strategy is "...the single, unified vision for the Army C⁴I community." [Ref. 6] Currently, the Strategy consists of two documents: *The Army Enterprise Vision* and *The Army Enterprise Implementation Plan*. *The Army Enterprise Vision* introduces ten principles vital to ensuring information dominance for the warrior. *The Army Enterprise Implementation Plan* outlines steps the Army must take to fulfill the vision. The strategy is best summarized in the Foreword by then, Army Chief of Staff, General Gordon R. Sullivan:

This capstone document outlines the strategy and the principles by which we will exploit current and future technologies, adopting new systems

and using executive decision making as a means to advance the capability of the Total Army Force. The advanced capabilities envisioned by this document will enable the Army to project and sustain the force, protect the force, win the battlefield information war, conduct precision strikes throughout the battlefield, and dominate the maneuver battle.

The Army Enterprise Strategy is founded upon well-established doctrinal foundations of Army Operations, FM 100-5, which we have updated and expanded to fit the requirements of the 21st Century.

The Army Enterprise Strategy is a structured approach to focus the efforts of the Army C⁴I community so that Army C⁴ systems support the warfighter in garrison and combat. Below are some key points the reader should infer from General Sullivan's excerpt; they foreshadow the content of The Army Enterprise Vision:

- The Army must "...exploit current and future technologies...." The Armed Forces are no longer the leader in technological advances; the commercial sector is. This means Defense procurement practices must accommodate the speed with which current commercial C⁴I technology is advancing in order to exploit future technology. This is a challenge because the Army and other Services cannot abandon technology they already have.
- The strategy must "...advance the capability of the Total Army Force." This means the strategy must address the requirements the Army has as a Service: to organize, train and equip itself to fight as a Service; to organize, train and equip itself to fight as part of a joint or combined force; and to sustain itself from a tactical and business perspective [Ref. 6].
- "The advanced capabilities envisioned by this document...." must allow the Army to execute across a wide spectrum of mission areas. Systems must provide flexibility because the threats facing the Army are less well-defined.
- The strategy must be "...founded upon well-established doctrinal foundations...." The Army must procure systems that compliment the ability to employ the Principles of War and the Tenets of Army operations (Figure 5).

B. THE ARMY ENTERPRISE VISION

The Army Enterprise Vision is a concise document that states a purpose, describes

THE TENETS OF ARMY OPERATIONS

1. INITIATIVE. Initiative sets or changes the terms of battle by action and implies an offensive spirit in the conduct of all operations. Applied to the force as a whole, initiative requires a constant effort to force the enemy to conform to the commander's operational purposes and tempos, while retaining freedom of action.
2. AGILITY. Agility is the ability of friendly forces to react faster than the enemy and is a prerequisite for seizing and holding the initiative.
3. DEPTH. Depth is the extension of operations in time, space, resources, and purpose. The Army must have the ability to gain information and influence operations throughout the depth of the battlefield.
4. SYNCHRONIZATION. Synchronization is arranging activities in time and space to mass at the decisive point.
5. VERSATILITY. Versatility is the ability of units to meet diverse mission requirements.

Figure 5. The Tenets of Army Operations [Ref. 3].

the threat the strategy must address, and lists ten principles to focus Army C⁴ systems support of operations.

1. The Purpose

"The purpose of the Army Enterprise Strategy is to support the US Army Warfighters into the 21st Century ... It synchronizes Army programs with the Joint Staff's C⁴I for the Warrior concept, business practices, and Defense Information Infrastructure" [Ref. 6]. This clear statement of purpose is the first indication that The Army Enterprise Strategy falls under the authority of joint doctrine. The strategy does this by design, not accident. The Army recognizes that in order to fight as part of a joint force, Army doctrine cannot conflict with joint Doctrine. Recall from the last chapter that Joint Pub 6-0 is the keystone document for the C⁴ systems series of publications. *It is based on The C⁴I For The Warrior Vision* and is the unifying strategy governing C⁴ systems support to joint operations. The Army

Enterprise Strategy weaves a common thread by identifying the US Army Warfighter as the core of its strategy for unifying the Army C⁴I community.

2. The Threat

The late Secretary of Defense, Les Aspin, stated the major dangers facing the post Cold War Armed Forces: rogue nuclear states, reversal of democracy in former communist states, regional threats, and domestic economic problems related to Defense cutbacks. Former Army Chief of Staff, General Gordon Sullivan described our future strategic environment as "...dynamic, uncertain, and unstable." It is clear that today's threat to the Army is less well-defined; we have no single major enemy. Each adversary poses a unique level of weaponry and command and control sophistication, and as such, poses a unique threat. Because of an increased reliance on COTS technology and components, the Armed Forces is less able to control sales of C⁴ systems to foreign states. This provides opportunity for future adversaries to enhance their command and control capabilities with the same technology as our Armed Forces. This is the threat that The Army Enterprise Strategy and future initiatives must address. [Ref. 6]

3. The Principles of The Army Enterprise Strategy

The Principles of The Army Enterprise Strategy are intended to ensure information dominance for the Army warfighter. Here again, the influence of joint doctrine and Field Manual 100-5, Operations, is evident. The ten principles are:

- Focus on the Warfighter.
- Ensure Joint Interoperability.
- Digitize the Battlefield.

- Capitalize on Space Based Systems.
- Modernize Power Projection Platforms.
- Optimize the Information Technology Environment.
- Implement Multi-Level Security.
- Ensure Spectrum Supremacy.
- Acquire Integrated Systems Using Commercial Technology.
- Exploit Modeling and Simulation.

a. Focus on the Warfighter

There is little question that the Armed Forces of the United States are equipped with the most technologically advanced equipment in the world. The technological advantage they enjoy, however, is still a function of the warfighters' ability to use and exploit the capabilities of that equipment. This is why the first principle of the Enterprise Strategy is to focus on the soldiers that will use and maintain the equipment. The strategy identifies five challenges to meeting the warfighters' needs:

- Challenge One: Provide a responsive requirements process that reflects warfighter's needs [Ref. 6]. The Louisiana Maneuvers and the Battle Labs are two initiatives intended to improve the requirements process for the warfighter. The Louisiana Maneuvers addresses Challenge One by providing an accelerated decision making process that addresses requirements forwarded from the field (Figure 6). The Battle Labs concept addresses Challenge One by providing a forum where new technologies and concepts are introduced and tested in a simulated environment (Figure 7).
- Challenge Two. Provide soldier friendly systems [Ref. 6]. Systems must not degrade soldiers' ability to perform combat missions. This means systems that require few procedures to send and receive information. Not only procedures related to automated processes, (i.e. keystrokes), but physical procedures such as the removal of combat or protective gear. [Ref. 6]

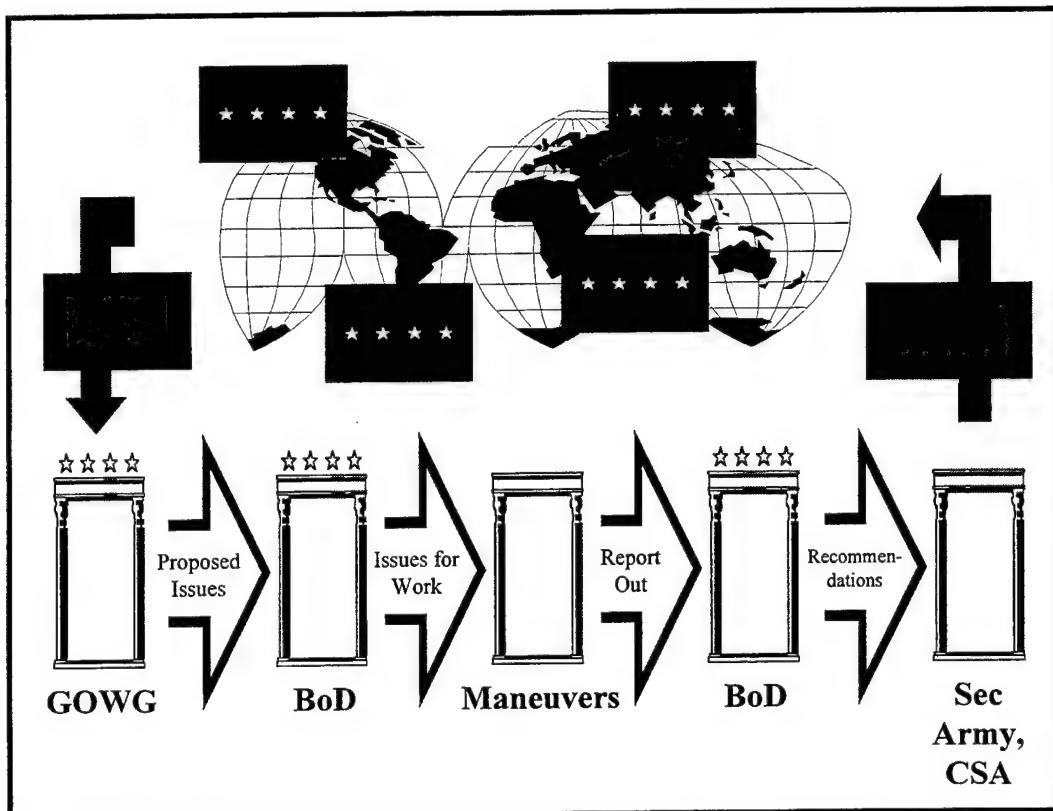


Figure 6. The Louisiana Maneuvers Decision Making Process. The process begins with issue nominations forwarded from the field. A General Officer Working Group (GOWG) reviews issues for consideration and passes the most important of those to the Louisiana Maneuvers Board of Directors (BoD) for deliberation. The BoD considers the issues and approves some of them for study. Members of the BoD then take responsibility for individual issues and supervise the study and evaluation of issues through joint, combined and multi-national exercises. After investigation, the members of the board report back to the BoD with observations, lessons learned, and options. The BoD then adds its recommendations and forwards the final product to the Secretary of the Army and Chief of Staff of the Army for decisions on funding and priority. After Ref. [7].

- Challenge Three. Provide more deployable systems. This challenge is fundamental to the warfighters' ability to accomplish the combat mission. As mentioned in defining the role of C⁴ systems, warfighters of today face a fast-paced operational tempo in training and combat. They must have systems that are as compact and mobile as they are. [Ref. 6]
- Challenge Four. Provide capable and reliable systems. These terms were defined in the Basic C⁴ Principles from Joint Pub 6-0, but are still a function of the warfighter in that they must articulate requirements that define

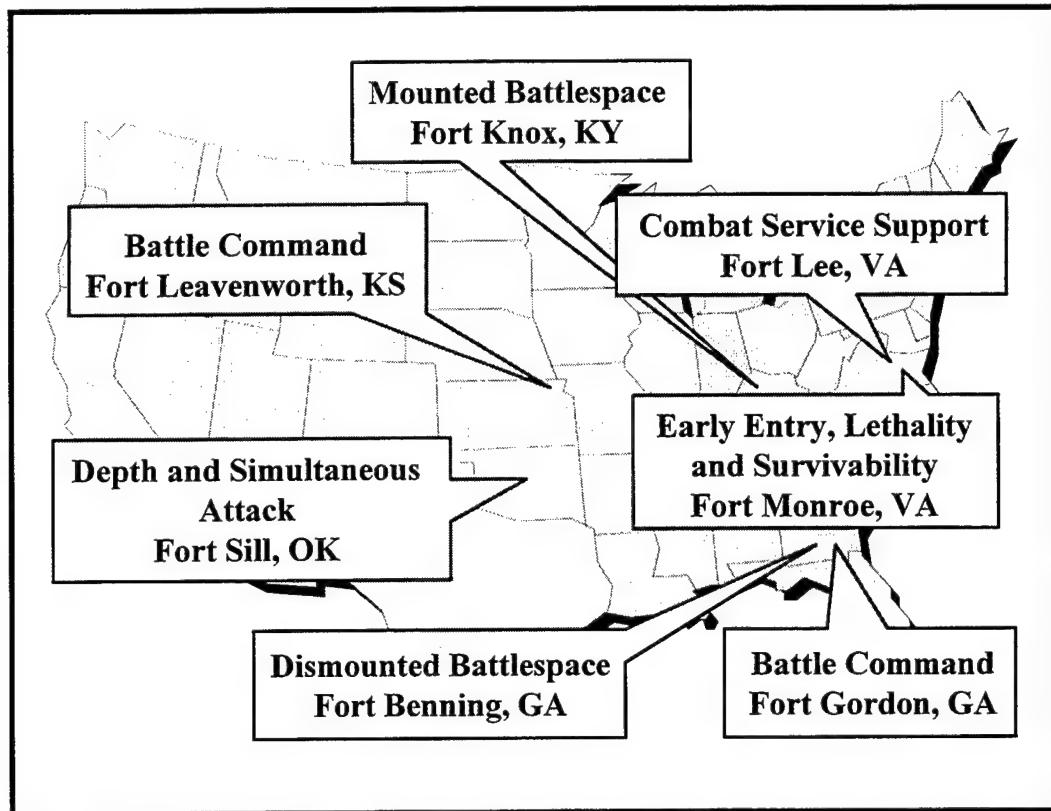


Figure 7. The Battle Labs Concept. The Army's Battle Labs are located at six installations around the nation. They provide a forum for functional integration of new technologies and concepts and help the Army determine requirements by focusing on emerging technologies using laboratory prototypes. The labs, though geographically separated, use C⁴I technology to link together to run a single simulation for experimentation. They help the Army to relate the cost of technology insertion to value added on the battlefield; this can avoid expenditure of money if the benefits do not justify the cost. After Ref. [7].

"capable and reliable."

- Challenge Five. Provide systems that function in both garrison and tactical environments. Meeting this challenge is necessary and makes sense economically. The ability to use the same systems in garrison and tactical environments reduces training requirements and the time required for a unit to transition from peace to war.

b. Ensure Joint Interoperability

This principle reemphasises the first of the Basic C⁴ Principles from Joint Pub

6-0 outlined in Chapter II. Interoperability is essential to mission success in joint and

combined operations. Army Field Manual 100-5, Operations, states:

The Army does not fight alone. It integrates its efforts in unified operations with its sister services, with other national agencies, and often with allied and coalition forces. By doing so, the Army's operational capabilities are enhanced, victory comes quicker, and friendly casualties are reduced. [Ref. 2]

For Services to fight together, they must be able to communicate and pass information with no intermediate processing. The Enterprise Strategy, in addition to stating interoperability as a principle, implies the importance of commonality, compatibility and standardization. These are concepts that promote interoperability.

Interoperability encompasses doctrine, procedures, and training - as well as systems and equipment ... Achieving interoperability will require adherence to industry standards for engineering, communications protocols, and data elements. Standards define a common environment in which new systems can be introduced at reduced risk. [Ref. 6]

c. Digitize The Battlefield

The goal of digitizing the battlefield is to provide the warfighter a digital network to assure C² decision-cycle superiority [Ref. 6]. The digitized battlefield exists from the highest command post down to the foxhole. The benefits are, improved transfer of information to provide a common operational picture (COP), and increased compatibility and commonality across battlefield operating systems. The end result is increased interoperability.

The COP is a concept whereby commanders, staff and their soldiers have a "common picture" of the battlefield at the same time on one terminal device. The common picture may include graphical displays of unit locations, attack routes, checkpoints and other tactical information of relevance all on one display. Updates occur at real-time or near real-

time and are sent to all commanders, staff and their soldiers. The benefit is a decrease in C² decision cycle time because the operational picture shows the most current information to commanders at all levels. Situational awareness is increased because every soldier, with the COP, has the same information regarding friendly and enemy locations.

Another benefit of digitizing the battlefield relates to commonality and compatibility. Recall from Chapter II that equipment is common when personnel trained on other (similar) equipment can operate and maintain it with no additional specialized training. Commonality also means interchangeability of repair parts and consumable items. [Ref. 3] Equipment is compatible when two or more systems can operate in the same environment without interfering with each other. [Ref. 3] Digitizing the battlefield facilitates commonality because there is only one type of information (digital) to contend with; this means less training of repair personnel and interchangeability of parts. Compatibility is enhanced because battlefield systems are all sending and receiving the same type of data.

d. Capitalize on Space Based Systems

The Armed Forces use space based systems to enhance strategic and tactical operations. At the strategic level, satellites transfer information between commanders in the field and national agencies. At the tactical level, satellites provide communications capability to remote areas where no communications infrastructure exists. Many special operations depend solely on satellites for communications. The smaller, power projection Army of today depends on space based systems to conduct split-based operations (Figure 8); a new concept made possible by rapid advances in C⁴I technology, particularly, space based systems. Space based systems also provide intelligence, positioning information, early

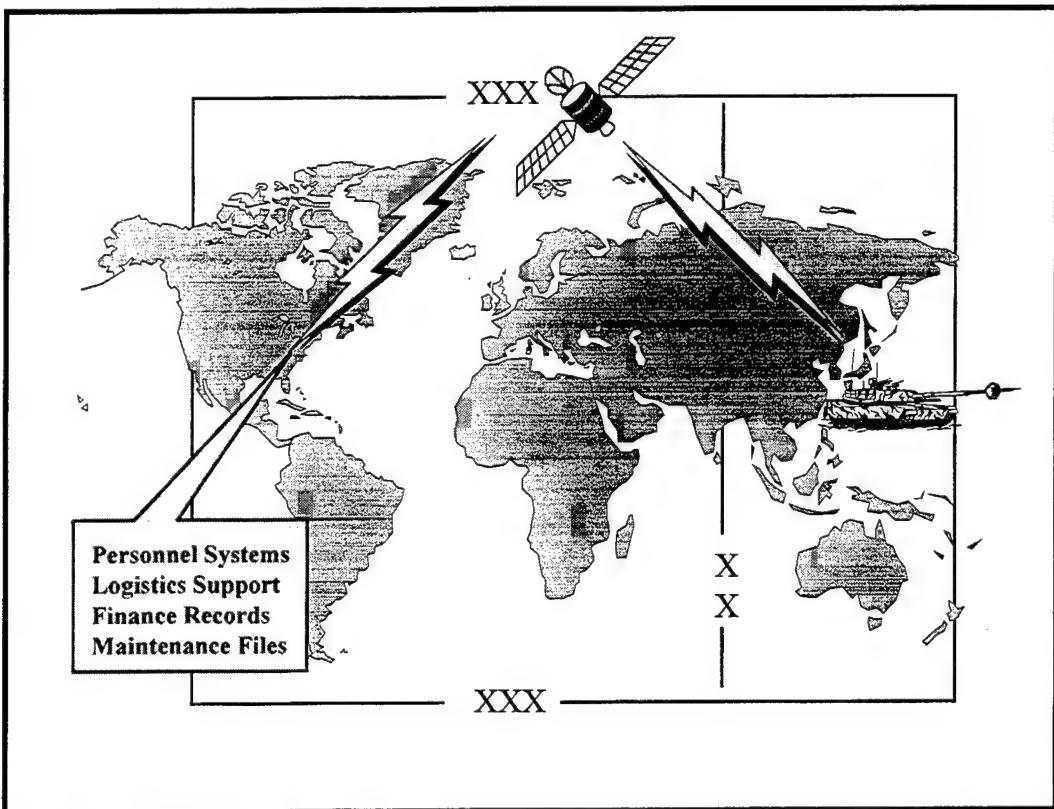


Figure 8. The Split-Based Operations Concept. Army Field Manual 100-5, Operations, discusses split-based operations: the full integration of supply and transportation functions into a vertical distribution system is critical. Enhanced, assured communications allow some logistics functions to be accomplished from CONUS or from another theater, only deploying support for those functions necessary. This is called split-based operations. In these operations, the industrial base of the United States (or a base in another theater) receives requirements and sends forward necessary support. Split-based operations reduce the burden on the deployment flow and prevent unnecessary stockage in theater. After Ref. [6].

warning, data processing, and imagery support to deployed forces. All these capabilities facilitate battlefield dominance, however, along with these capabilities come some challenges. The largest of these is the dependence on commercial satellite usage to handle the overload on military satellites. The Enterprise Strategy calls for initiatives to establish procedures to allow military use of commercial satellites. Those initiatives will address issues such as interoperability, security and rights of usage. The military's increased use of

COTS technology and equipment will help resolve these issues. [Ref. 6]

e. Modernize Power Projection Platforms

The ability to project the power of the Army depends on a strong sustaining base. The CONUS installations are the power projection platforms for today's Army. As described in Figure 8, they allow the Army to perform split-based operations, thereby taking over many of the rear-area operations formerly performed in the theater of operations. Modernizing CONUS based installations supports split-based operations and allows the Army to reduce requirements for strategic airlift and in-theater stockpiles. Additionally, fewer soldiers and equipment are exposed to the dangers of combat; this also allows for quicker entry and exit of forces. [Ref. 6]

f. Optimize The Information Technology Environment

This principle is a warning as much as a statement of guidance. It says that while the Army leverages its capabilities with C⁴I technology, it must do it smartly because there are fewer resources to procure technology. Maximum application of the concepts of standardization, commonality and compatibility are essential to implementing this principle. It is important to maximize the longevity of equipment even in an area where technology improves so rapidly. An excerpt directly from The Enterprise Strategy best explains the essence of this principle:

Our overall approach to information systems will address the requirements of the warfighter and the economic imperative to provide modernized technology in this era of decreasing resources. Army systems will be modernized and leveraged, especially in the C⁴I arena, so that they can be exported for other US and Allied use. Smart investments today in information technology will generate savings and maintain information superiority in the future. [Ref. 6]

g. Implement Multi-Level Security

Many of the Joint Pub and Enterprise Strategy principles up to this point refer to the need for economy and efficiency in the development and procurement of C⁴I systems. A single system that can do as many functions as possible without degrading capability is the goal. It is an ambitious goal and requires multi-level security to achieve it. A multi-level security device allows multiple users at different access (classification) and sensitivity (compartment) levels to access one system at the same time. It also allows one user to access different classification and compartment levels at the same time on one system. Though many levels *can* be accessed at one time, by one user, a multi-level security system will only allow the user to access information they are authorized. [Ref. 8] In the absence of such a system, a soldier may have to access information with different sensitivity levels on different systems; they may even be geographically separated. A multi-level security system will allow soldiers to get the information they need in one place, regardless of the security level. This principle supports initiatives to standardize and modularize support systems and allows the Army to achieve cost savings in development, procurement and maintenance.

h. Ensure Spectrum Superiority

Although advances in C⁴I technology allow the Army to enhance warfighting capabilities, the systems cannot operate without continuous and uninterrupted use of the electromagnetic spectrum. The importance of this principle, first discussed in the Basic C⁴ Principles in Joint Pub 6-0, is echoed as a principle in The Enterprise Strategy. As the number of electronic battlefield systems increases, so does the dependance on the electromagnetic spectrum. The Enterprise Strategy calls for two actions to ensure spectrum

supremacy: a single authority within a task force responsible for the spectrum and active participation in policy formulation. The single authority responsible for the spectrum will use techniques (technological or otherwise) to allocate the spectrum as the scarce resource it is becoming. Coordination will be essential to success in implementing this principle. To facilitate the efforts of the spectrum authority at the task force level, the Armed Forces must participate in and influence the formulation of international and allied policy regarding the electromagnetic spectrum to our benefit.

i. Acquire Integrated Systems Using Commercial Technology

In the Foreword of the Enterprise Strategy, General Sullivan calls for the Army to "... exploit current and future technologies as a means to advance the capability of the Total Army Force". The principle of acquiring integrated systems using commercial technology addresses his comment directly. The commercial sector is the defacto leader in information and C⁴I systems technology and the generation of new commercial technology happens quicker than the acquisition cycle allows the Services to buy it. In order to exploit these trends, the Enterprise Strategy calls for the Army to affect the streamlining of the acquisition cycle, work with industry to influence new technology development and standardization, exploit current emerging technology, and only resort to Army-funded technology when necessary [Ref. 6]. The benefits of implementing this principle are cost savings due to the reduced price of technology based on commercial demands, and the avoidance of costly research and development. Additional savings, as in the commercial sector, will come in the form of technology upgrades. Through carefully planned improvements, systems will advance in an evolutionary manner rather than developing new

systems [Ref. 6].

j. Exploit Modeling and Simulation

The days of costly field training exercises are numbered. Experience gained through modeling and simulation provides a cost effective means to train soldiers, rehearse missions and evaluate different courses of action [Ref. 6]. The same concept that produces effective training in the field applies to this principle; training must be as realistic as possible. In order to do that with respect to modeling and simulation, many of the other principles must be implemented first or concurrently. The Enterprise Strategy identifies three particular challenges to implementing this principle:

- Warfighters must be able to use tactical equipment in the distributed simulation environment [Ref. 6]. The Battle Labs concept is an example of an initiative already underway.
- Tactical equipment must function the same in tactical and simulated environments [Ref. 6]. Meeting this challenge requires close coordination between the Army and technology developers in the requirements generation process.
- Decisions required of the warfighter must be the same in tactical and simulated environments [Ref. 6]. Again, meeting this challenge requires close coordination between the Army and technology developers in the requirements generation process. It also involves integration of the actual systems that provide information to commanders.

The ten Principles of the Enterprise Strategy provide guidance for Army C⁴ systems support to operations. They are the essence of The Army Enterprise Strategy Vision. They serve little purpose without an executable implementation plan.

C. THE ARMY ENTERPRISE IMPLEMENTATION PLAN

The Army Enterprise Implementation Plan is the second of two documents that make

up The Enterprise Strategy. It is a detailed document that goes far beyond the purpose of this thesis. It does, however, deserve discussion at a macro level for familiarization.

1. The Purpose

The purpose of The Army Enterprise Strategy Implementation Plan is to define the steps necessary to implement the principles outlined in The Army Enterprise Strategy Vision [Ref. 9]. It provides the "...institutional framework for the evolution and modernization of Army C⁴I systems." The plan lays a roadmap for guiding the Army C⁴I transition into the 21st century. It consists of three parts:

- An independent assessment of existing systems; baselines under current rules and assumptions [Ref. 9].
- An investment strategy for the future; a blueprint under new rules and assumptions [Ref. 9].
- An action plan to implement the blueprint [Ref. 9].

a. Assessment of Existing Systems

The assessment of existing systems looks at why the Army must change the way they develop, procure and use C⁴ systems. It identifies eleven paradigms that are affecting the Army and the Army C⁴I community. The eleven shifting paradigms are all motivated by either new technology or a new conceptual/doctrinal way of thinking. Table 1 summarizes the eleven shifting paradigms. It represents the old way of thinking (Old Model), the factors motivating change (New Concepts/Technology), and the new way of thinking (New Model).

SHIFTING PARADIGMS		
Old Model	New Concept/Technology	New Model
A Forward Deployed Army.	A Force Projection Army using Split Based Operations.	Installations as Corps or Division Rear Area.
Service focused information using Service Stovepipes.	Joint Operations.	Joint and Combined Information using Joint C ⁴ I technology.
Deploy Extensive Information Management Systems to the field	Space Based Systems, Personal Computers and switching technology.	Send only terminal devices forward.
Hardware dominated weapon systems.	Computer technology and software engineering practices.	Software enables combat power.
Focus on targeting enemy weapon systems.	Real time information distribution.	Information Warfare that targets information targets like sensors, C ² posts.
Use of umbrella communication grids to blanket an area.	Force Mobility requiring forces to move great distances quickly.	Use of space based systems, remote terminals, and automation support cells.
Acetate and grease pencils.	The information technology revolution.	Imagery, simulation, COP, and the ability to print locally.
Service and functionally oriented stovepipe systems.	Distributed databases.	Process oriented support based on the mission area.
Manual, serial coordination. Staffing in sequence.	Groupware.	Electronic coordination.
Print plants involving multi-step processes.	Direct publishing access	Electronic preparation and distribution.
Military unique information mission area equipment.	High tech changes in: Commercial satellite communications. National and international commercial standards and protocols. Commercial open systems architecture. COTS and Non-developmental items (NDI).	Start with COTS and modify as needed or augment military unique with COTS. Use of standard commercial switches. Use of commercial equipment and software. Use of COTS.

Table 1. Shifting Paradigms Affecting Army C4I. After Ref. [9].

The factors motivating change, in some cases are a result of the post-cold war decrease in resources. The Force-Projection, CONUS-Based Army is such an example, however, it is important for the reader to note that the technology revolution serves the Army well; it provides a means to offset force reductions by quickly providing information that allows for a better application of the smaller force. Additionally, the proliferation of the technology has driven the cost down which also serves a resource constrained Army well.

b. The Investment Strategy For The Future

This portion of The Implementation Plan graphically depicts the current investment in the Army's baseline systems, what those systems will migrate to in the near to mid term, and then, where they will be in the year 2010. Near to mid term is defined as from the year 1996 to 2001 and is based on the idea of incorporating technology into current systems as long as those systems move the Army forward in accordance with the principles outlined in The Enterprise Strategy Vision. Where the Army wants to be in the year 2010 was described in a visionary excerpt from General Sullivan on the 2010 battlefield. A general example of the graphical investment strategy is depicted in Figure 9.

c. The Action Plan

This portion of The Enterprise Implementation Plan is based on the independent assessment of existing systems, the investment strategy for the future, and The Enterprise Strategy Vision principles. This part of the Implementation Plan is authored by The Enterprise Strategy General Officer Steering Committee and consists of nine tasks. The nine tasks give direction and proponency to different agencies of the Army for action. It is not important for the reader to know what these specific tasks are, but rather that they exist.

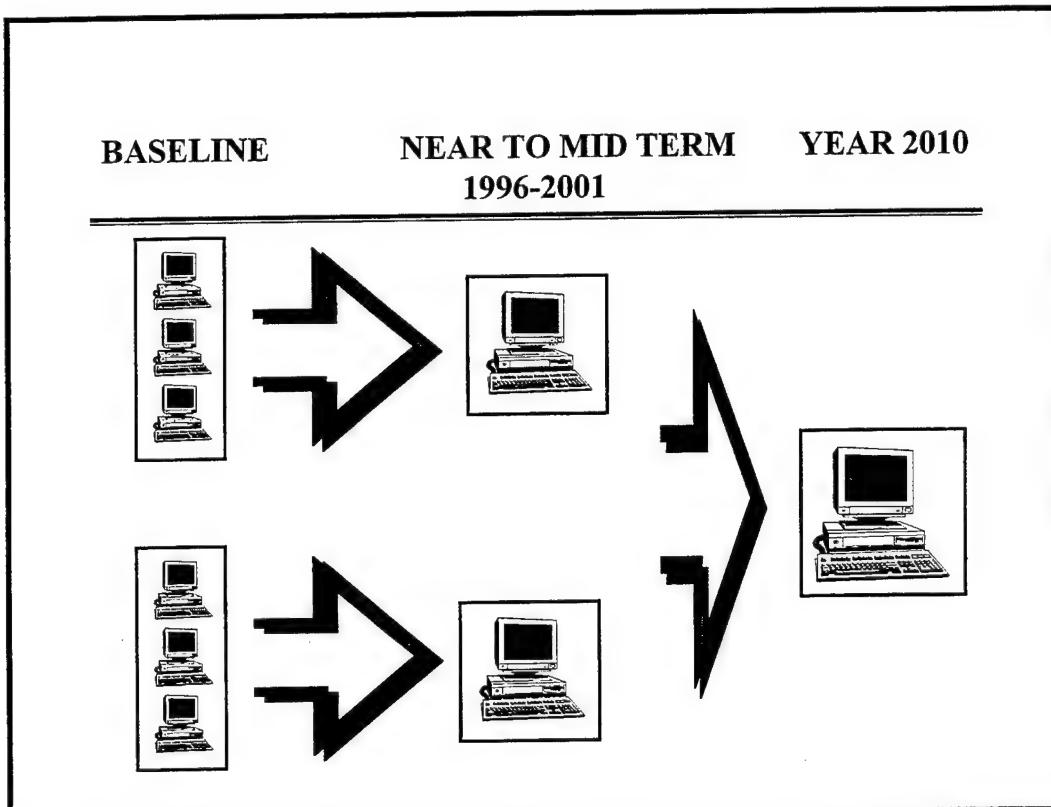


Figure 9. The Enterprise Investment Strategy. In this example, the baseline column represents systems that control information from a specific information mission area such as maneuver, field artillery, or intelligence. The near to mid term column represents the product of the baseline systems' migration to a single integrated system offering all the functional capabilities of the baseline systems. The final column of The Enterprise Investment Strategy represents a future system embodying General Sullivan's excerpt about the 2010 battlefield. After Ref. [9].

D. SUMMARY

This chapter provided an overview of the Army level guidance covering C⁴ systems support to operations: The Army Enterprise Strategy, consisting of The Enterprise Strategy Vision and The Enterprise Strategy Implementation Plan. The Vision provides ten principles intended to focus efforts within the Army C⁴I community to ensure battlefield information dominance for the warfighter. The Implementation Plan established a method for the Army to implement the principles outlined in The Vision. This Army guidance falls under the

authority of the doctrine found in Joint Pub 6-0 and is influenced by Field Manual 100-5, Operations. Initiatives such as Louisiana Maneuvers and the Battle Labs concept provide a mechanism for soldiers and scientists to focus technology development on warfighter needs supported by the C⁴I principles. This chapter was a continuation of the sequenced approach showing how the guidance at different levels of the Armed Forces relate to and support each other and the C⁴I For The Warrior Vision.

Understanding that there are threads of continuity that start at joint doctrine and flow through Army guidance sets the doctrinal foundation for the design, development and procurement of Army C⁴ systems. This chapter is the second step in showing what documents govern and influence the functional design of the Army Tactical Command and Control System.

IV. ARMY OPERATIONS

The previous chapter introduced the reader to The Army Enterprise Strategy. It outlined principles, implementation plans, and showed the reader how The Army Enterprise Strategy falls under the authority of joint doctrine. Army Field Manual 100-5 is referenced throughout the previous chapters as it relates to principles in joint and Army C⁴I doctrine. This chapter summarizes how the Army develops combat power and is the last of three guiding documents discussed in the purpose of this thesis; it gives the reader the foundation for understanding the functional design of The Army Tactical Command and Control System.

A. COMBAT POWER

The Army uses combat power to achieve its goals in combat. The accepted Department of Defense and NATO definition of combat power is:

The total means of destructive and/or disruptive force which a Military unit/formation can apply against the opponent at a given time [Ref. 1].

Army Field Manual 100-5, Operations, expands on this definition by saying:

Combat power is created by combining the elements of maneuver, firepower, protection and leadership. Overwhelming combat power is the ability to focus sufficient force to ensure success and deny the enemy any chance of escape or effective retaliation ... Overwhelming combat power is achieved when all combat elements are violently brought to bear quickly, giving the enemy no opportunity to respond with coordinated or effective opposition. [Ref. 3]

The reader should infer from these two definitions that combat power is a real phenomenon; it is the *realized* capability of a force to achieve results in combat [Ref. 10].

Furthermore, combat power is derived from an energy source called combat potential:

Combat potential is the latent capacity of individual fighting and supporting elements organized as a force capable of achieving combat results [Ref. 10].

Combat potential exists in two states: designed and actual combat potential.

Designed combat potential exists notionally under ideal conditions and actual combat potential exists under current conditions. In either case, the broad definition of combat potential includes "fighting and supporting elements" and is transformed into combat power by command through instructions. [Ref. 10] All the Services apply and develop combat power differently; the Army *creates* combat power by combining four elements, in concert, against the enemy. The four elements, from the Army Field Manual 100-5 expanded definition of combat power, are maneuver, firepower, protection and leadership. Creating combat power only provides a force at the beginning of battle; in order to *sustain* combat power, the Army integrates and coordinates seven combat functions with the four elements. The seven combat functions are intelligence, maneuver, fire support, air defense, mobility and survivability, logistics, and battle command.

1. The Elements Of Combat Power

a. *Maneuver*

Recall from Figure 3 in Chapter II that maneuver is the fifth Principle of War. The Army also considers maneuver to be a dynamic of combat power. Maneuver gives friendly forces the advantageous position or allows the enemy to maneuver into a disadvantageous position in order to affect delivery of fires. Maneuver only refers to position of forces in relation to the enemy and must be combined with the elements of

firepower and protection to be completely effective. Effects of positional advantage are surprise, psychological shock, physical momentum, massed effects, and/or moral dominance of the enemy. These goals should sound familiar to the reader; they are closely related to the other Principles of War (Figure 3) and Tenets of Army Operations (Figure 5). [Ref. 3]

b. Firepower

Firepower is the “destructive and/or disruptive force” portion of the DoD and NATO definition of combat power. Firepower is the teeth of the friendly force and may be direct (i.e. fire from an Armor Company) or indirect (i.e. fire from a Field Artillery Battery or naval gunfire). While maneuver is rarely effective without firepower, there are types of firepower that can be effective without maneuver. An example is the employment of indirect weapon systems using munitions as laser guided bombs, and integrated target acquisition systems. Whether direct or indirect, the effects of firepower are maximized when combined with maneuver. [Ref. 3]

c. Protection

Protection refers specifically to the combat potential of a unit. Protection has four components that when applied effectively, increase the *actual* combat potential of a unit. The four components of protection are:

- Operational Security (OPSEC) and deception operations. This component includes measures such as reconnaissance, counterreconnaissance, camouflage, dispersion of units, and fortified fighting positions. [Ref. 3]
- Maintenance of soldier health and morale. This component includes measures to maintain the equipment and supplies the soldiers require to perform effectively in combat. It also includes measures to ensure adequate health services for soldiers. [Ref. 3]

- Safety. This component includes active measures employed by commanders to identify and mitigate dangers that soldiers face in training and combat. [Ref. 3]
- Avoidance of fratricide. This component includes measures to avoid the killing or wounding of friendly soldiers. [Ref. 3] There are many initiatives working towards this combat problem. C⁴I systems will help by providing a clear and common picture of the battlefield. Other measures include disciplined operations carried out by the integrated forces of an Army Task Force [Ref. 3]. This means application of firepower and support operations at the right time and place as specified by an Operations Order (OPORD).

Application of all four of the components of protection will increase the actual combat potential of a unit towards the designed combat potential. The reader should note that protection is the single element of combat power that can affect combat potential before, during and after direct combat. The goal is always to maximize actual combat potential to result in the maximum combat power.

d. Leadership

The Army considers leadership to be the most important of the four elements of combat power. The specific aspect of leadership referred to here is the ability of the Officers and Non-Commissioned Officers of the Army to combine and employ the other three elements of combat power. This ability is the culmination of experience combined with professional education including history, doctrine, theory, and successful personality traits and techniques employed by previous leaders. It is:

... taking responsibility for decisions; being loyal to subordinates; inspiring and directing assigned forces and resources towards a purposeful end; establishing a teamwork climate that engenders success; demonstrating moral and physical courage in the face of adversity; providing the vision that both focuses and anticipates the future course of events [Ref. 3].

When opposing forces are evenly matched, the ability of the leader to combine and employ the other three elements of combat power will be the decisive edge.

[Ref. 3]

2. The Combat Functions

In order to plan and analyze complex Army operations, leaders break the operation into seven functional operating systems. “Systems” in this sense is meant to represent an operational process, not a hardware/software combination such as a “command and control system.” They are called the Battlefield Operating Systems (BOSs) and exist (as a function) at every level of war. The establishment of these BOSs provide the direct link between joint and Army C4 doctrine and the functional design of The Army Tactical Command and Control System.

a. Intelligence

Intelligence is the first Battlefield Operating System. It affects combat operations before, during and after combat. It is the process/function of gathering and fusing information about the enemy as it affects friendly operations. Its existence as a Battlefield Operating System should not surprise the reader; references to intelligence operations are found throughout joint and Army C⁴I doctrine. Examples found in this thesis are in Chapter II; the first two functions of the Lawson Loop are to *sense* and *process* external information. Recall that *collection* is the first function of a of a C⁴ system and that Information Quality Criteria is crucial to preventing information overload. Without *collected* information, the Cognitive Hierarchy doesn’t exist and Information Fusion, the forth Objective of C⁴ Systems is not necessary.

b. Maneuver

Maneuver is discussed as a Principle of War and as an element of combat power. The general concept is the same with respect to Maneuver, the Battlefield Operating System. It is to put the enemy at a positional disadvantage. Recall that maneuver must be combined with firepower to be effective.

c. Fire Support

Fire Support is the function by which firepower is brought to bear when combined with maneuver. It exists as a Battlefield Operating System because it requires the synchronization and coordinated efforts of *organic and supporting* fire support elements. Because most of the commander's indirect firepower comes from external sources (supporting fire support elements), firepower must be synchronized through the *function* of fire support in order to best use all available fires throughout the depth of the battlefield.

[Ref. 3]

d. Air Defense

Air Defense operations, as a Battlefield Operating System, allow commanders to focus and exploit the full capability of their maneuver and firepower *elements* by offering protection from enemy air threats. The majority of this responsibility falls on ground based air defense units deployed throughout a theater. Those units provide air defense throughout the depth of the battlefield against enemy aircraft, missiles (all altitudes), and unmanned aerial vehicles. Though the air defense function offers protection, it is not in the context of protection as an element of combat power. This type of protection is closer related to the maneuver and firepower elements of combat power since it enhances freedom of maneuver

of friendly forces. [Ref. 3]

e. Mobility and Survivability

Mobility and Survivability, as a Battlefield Operating System, is related to the maneuver, firepower, and protection elements of combat power. While Air Defense provides freedom of maneuver by reducing the enemy air du-eat, Mobility and Survivability is the Battlefield Operating System that, literally, enhances freedom of maneuver of friendly forces. There are actually two components to the Mobility portion of the BOS: mobility operations and countermobility operations. Mobility operations increase trafficability for friendly forces. It includes missions to breach enemy obstacles, improve roads, build new roads, provide bridges and rafts for river crossing, and identifying trafficable routes for maneuver forces. Countermobility operations disrupt or deny the enemy its freedom of maneuver. These missions include demolition of roads and bridges, building obstacles along anticipated enemy routes of attack, or the use of smoke to hinder enemy maneuverability. Survivability is the BOS link to the protection element of combat power. These missions include those intended to deceive the enemy, OPSEC, Nuclear, Biological and Chemical (NBC) operations, use of camouflage, dispersion of units, and the building of fortified/hardened fighting positions. [Ref. 3]

f. Logistics

Logistics, as a Battlefield Operating System, is the single function that relates to and facilitates all four of the elements of combat power. The Logistics BOS "... provides the physical means with which forces operate" It is the process of planning and executing the sustainment of forces in support of military operations. [Ref. 3] A key to logistics

operations is its *uninterrupted flow* of supplies to maneuver and supporting units. This uninterrupted flow requires intense planning, anticipation, and flexibility on the part of logistics planners so that the maneuver commander's actions are not limited by logistics constraints. Army Field Manual 100-5, Operations, puts logistics into perspective by saying:

At the tactical level it focuses on the traditional CSS functions of arming, fixing, fueling, manning, moving, and sustaining the soldier and his equipment. Logistics cannot win a war, but its absence or inadequacy can cause defeat. [Ref. 3]

g. *Battle Command*

The Battle Command Battlefield Operating System is very closely related to the command and control process (Lawson Loop Model) discussed in Chapter I of this thesis. Army Field Manual 100-5 describes the modern commander's challenge with respect to Battle Command:

Ultimately, they must assimilate thousands of bits of information to visualize the battlefield, assess the situation, and direct the military action required to achieve victory. Thinking and acting are simultaneous activities for leaders in battle. [Ref. 3]

The art of Battle Command influences all aspects of battle because it is a combination of leadership and decision making. Looking back at the section on leadership as an element of combat power, the reader should note that leadership not only includes those decisions that leaders make, but those that their subordinates make based on the leader's vision and the teamwork climate established.

Leadership is a thesis topic in itself and is defined and discussed in many Service manuals. There are differing definitions, all closely related, but what is never in dispute, is that leadership is a *function* whereby leaders make decisions based on many

dynamics and vast amounts of information. It should come as no surprise to the reader that it is the last of the Battlefield Operating Systems because it requires a clear understanding of the other BOSs to successfully execute. The last statement is the premise for the functional design of the Army Tactical Command and Control System; an overarching command and control system that incorporates subordinate functional control systems to aid commanders in their decision making process.

B. SUMMARY

This chapter summarized how the Army develops combat power in cooperation with the components of a Joint Task Force. Army Field Manual 100-5 is the last of three guiding documents discussed in the purpose of this thesis; it gives the reader the foundation for understanding the functional design and capabilities of The Army Tactical Command and Control System. This chapter defined combat power and combat potential and the relationship between the two. It also discussed the four element of combat power: maneuver, firepower, protection, and leadership. It also discussed the seven functional operating systems, called the Battlefield Operating Systems, that the Army uses to plan and analyze complex Army operations: intelligence, maneuver, fire support, air defense, mobility and survivability, logistics, and battle command. This chapter also identifies where the seven BOSs are integrated into the four elements of combat power. This chapter speaks less of C⁴I specific doctrine and more of Army operational doctrine; it is the necessary transition to the discussion of the functional design and capabilities of The Army Tactical Command and Control System.

V. THE ARMY TACTICAL COMMAND AND CONTROL SYSTEM

The last chapter summarized a portion of Army Field Manual, 100-5, Operations; specifically, how the Army develops combat power. It gave the reader the foundation for understanding the functional design of The Army Tactical Command and Control System. This chapter familiarizes the reader with an Army C⁴I system that shows evidence of doctrinal C⁴I principles. As in former chapters, it is the building block for the next chapter. In familiarizing the reader, it discusses capabilities only; the threads of continuity that travel from joint doctrine through Army doctrine into ATCCS are drawn in the final chapter. This chapter gives the reader an introduction to the components and capabilities of the ATCCS. This chapter also discusses the hardware and communications hub that supports the ATCCS, and finally, takes the seven Battlefield Operating Systems (BOSSs) and shows the reader how those BOSSs are the basis for the five Battlefield Functional Area Control Systems (BFACS) of the ATCCS.

A. THE COMPONENTS OF ATCCS

The Army Tactical Command and Control System is the Army's primary tactical C² system at echelons Corps and below. The functional design of the ATCCS is an overarching command and control system (ATCCS in itself) comprised of subordinate functional control systems (the BFACS). Recall that the Army considers the seven BOSSs essential to *sustaining* combat power. From these seven BOSSs are derived the five BFACS that comprise the ATCCS. The Intelligence BOS is controlled by the All Source Analysis System (ASAS), the Maneuver BOS is controlled by the Maneuver Control System (MCS),

the Fire Support BOS is controlled by the Advanced Field Artillery Tactical Data System (AFATDS), the Air Defense BOS is controlled by the Forward Area Air Defense Command, Control and Intelligence System (FAAD C²I), and the Logistics BOS is controlled by the Combat Service Support Command and Control System (CSSCS). This accounts for five of the BOSs. The other two BOSs, Mobility and Survivability, and Battle Command are not forgotten; they are integrated into the other five. Since Mobility and Survivability enhances maneuver, that is where it is controlled; in the Maneuver Control System. As the overarching BOS, Battle Command, is the function that integrates and synchronizes the other six. The ATCCS integrates and synchronizes the other BFACS. It represents the Battle Command combat function. Table 2 depicts the functional relationship between the seven BOSs and their five controlling BFACS.

RELATIONSHIP BETWEEN COMBAT FUNCTIONS AND THE BATTLEFIELD FUNCTIONAL AREA CONTROL SYSTEMS:		
The Seven Combat Functions ->	Are Controlled by These Battlefield Functional Area Control Systems ->	Which Make-up The Overarching Command And Control System.
Intelligence	All Source Analysis System	The Army Tactical Command and Control System
Maneuver	Maneuver Control System	
Mobility and Survivability		
Fire Support	Advanced Field Artillery Tactical Data System	
Air Defense	Forward Area Air Defense Command, Control and Intelligence System	
Logistics	Combat Service Support Command and Control System	
Battle Command		

Table 2. Relationship Between the Seven BOSs and Their Respective BFACS.

Truly a system of systems, the entire ATCCS is supported by a Common Hardware and Software (CHS) concept and can be separated into the five BFACS connected by a Communications Hub. The Communications Hub is further composed of three smaller communication systems to be discussed later in this chapter. The ATCCS provides the C² framework for decision making horizontally between BFACS at each echelon, and vertically from battalion to corps level. Figure 10 depicts this ATCCS framework.

B. COMMON HARDWARE AND SOFTWARE

The Common Hardware and Software Concept (CHS) is designed to "... minimize the proliferation of unique tactical computer systems." [Ref. 11] It is based on common Commercial of the Shelf (COTS) computers and peripherals. The Army intends to lower

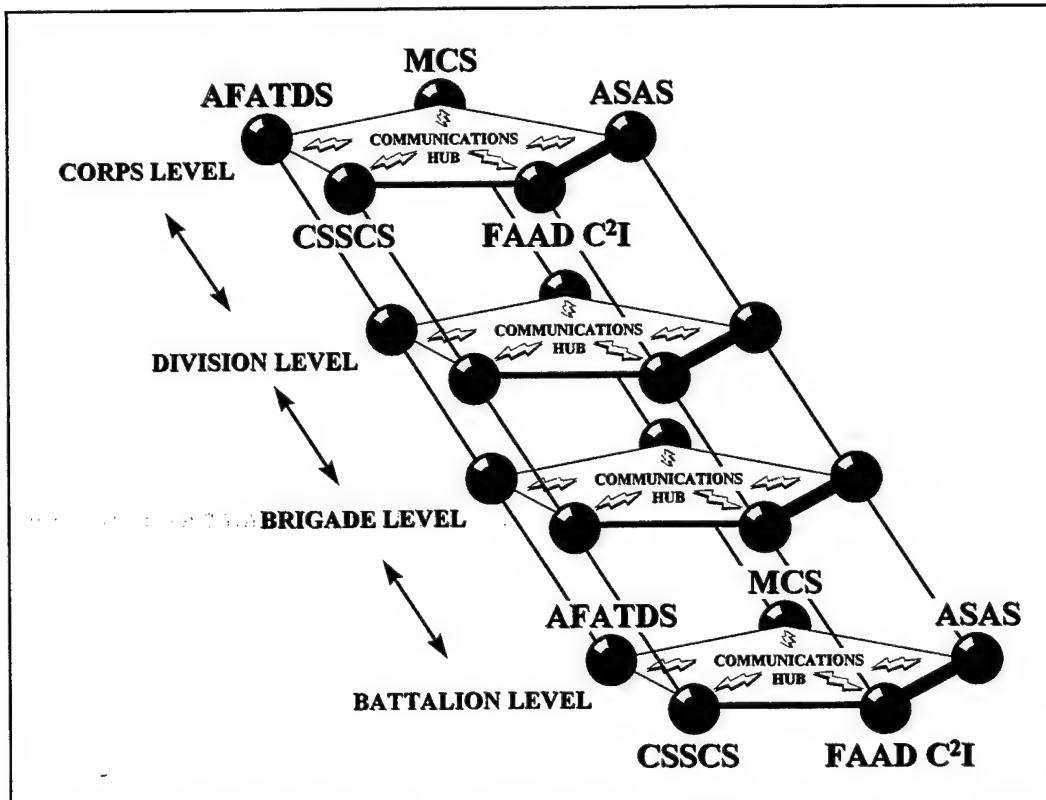


Figure 10. The Army Tactical Command and Control System. After Ref. [12].

life-cycle costs by standardized automation, protocols, and reusable software [Ref. 12]. Other goals include accelerated development, accelerated testing and fielding, and streamlined user training requirements [Ref. 11]. The common hardware ranges from portable to high end workstations that are ruggedized for use in wheeled and tracked vehicles, shelters and tents. The common software includes UNIX and POSIX operating systems, relational database management systems, and graphics support software. Table 3 summarizes the four processing units in the CHS concept; they are the hand-held (HTU), portable (PCU), transportable (TCU), and lightweight (LCU) computer units.

CHARACTERISTICS OF COMMON HARDWARE IN CHS								
Nomenclature Capabilities	HTU	PCU	TCU	TCU RISC	LCU	HCU2 RISC	TCU2 RISC	HTU2
Processor Number	80286	68020	68040	RISC	80486	RISC	RISC	80486
Clock Speed in Megahertz	6 12	16	25	99	25 33 66	50	85	
Data Rates in Megabits Per Second	.5 1	2	22	124	10 14 20	129.4	112.5	
RAM in Megabytes	2-6	4-20	8-128	80-400	8-32 8-32 8-128	32-512	16-256	4-32

Table 3. Characteristics of Hardware in the CHS Concept. After Ref. [12].

C. THE COMMUNICATIONS HUB

The communications hub that provides connectivity for the ATCCS is comprised of three systems. Referring again to Figure 10, the Communications Hub provides the connectivity between BFACS at each level as well as between levels. Figure 11 depicts the three systems that make up the Communications Hub and provide connectivity at any of the

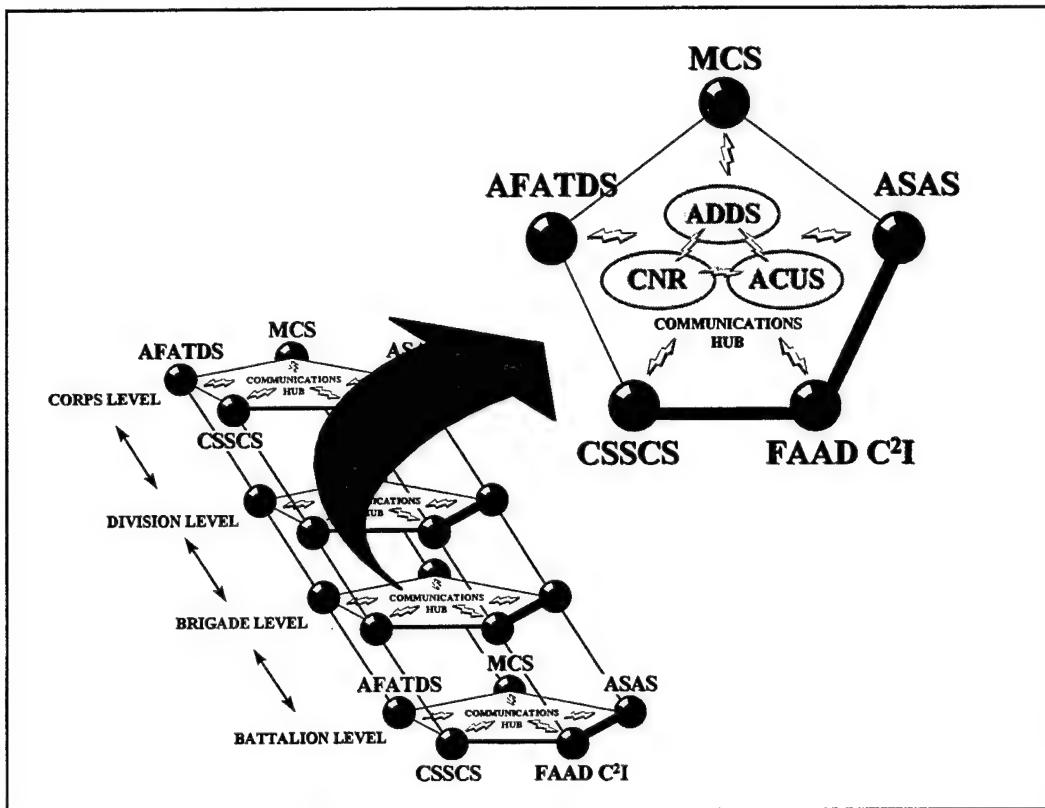


Figure 11. The Communications Hub of the ATCCS.

four levels and between levels. The three systems are the Army Data Distribution System (ADDSS), the Combat Net Radios (CNR), and the Area Common User System (ACUS). Each of these systems is also comprised of systems.

1. The Army Data Distribution System (ADDSS)

The ADDSS is several systems that provide data communications, position location reporting, navigation and identification for units using ATCCS. The systems are the Enhanced Position Location Reporting System (EPLRS), and the Joint Tactical Information Distribution System (JTIDS).

a. *EPLRS*

EPLRS reduces contention for valuable combat net radio bandwidth;

approximately fifty percent of radio traffic consists of position location messages and requests [Ref. 14]. The system uses manpacked, vehicle-mounted, and aircraft-mounted transceivers (called EPLRS User Units EPUU) to report location, friendly identification, and data communications to a Net Control Station (NCS). A typical system at Brigade Level consists of one NCS and 250 EPUUs. [Ref. 14] EPLRS gives primary support to AFATDS, ASAS, and MCS [Ref. 15]. EPLRS also interfaces with the Global Positioning System (GPS), and JTIDS.

b. JTIDS

JTIDS is a high capacity system providing integrated communications, navigation information, and identification of friend or foe capabilities to aircraft, surface ships, and mobile ground units. The system employs Electronic Counter-Countermeasures (ECCM) by using frequency hopping techniques. JTIDS, also known as Link 16, provides its users with formatted and unformatted message capability, and as an airborne relay, can provide over-the-horizon communications. [Ref. 16] The Army uses JTIDS for air defense artillery to pass tracking information from sensors to command processing centers [Ref. 14]. JTIDS provides the bulk of interoperability capability for ATCCS in the form of three classes of terminals. Table 4 summarizes the three classes of JTIDS terminals.

2. The Combat Net Radios (CNR)

The Single Channel Ground/Airborne Radio System (SINCGARS) is a VHF-FM radio providing primarily voice communications for Army units down to team level. Although not part of the ADDS, SINCGARS also provides low rate data connectivity for the ATCCS. The radio can be operated in three modes for tactical use: an ECCM mode

CLASSES OF JTIDS TERMINALS	
Class	Platform/Use
Class I	- For use on large aircraft such as Advanced Warning And Control System (AWACS) aircraft, surface ships, and as gateway facilities for ground-based networks.
Class II	- For use on fighter aircraft and small ships.
Class III	- For use in mobile ground units and UAVs.

Table 4. Classes of JTIDS Terminals. After Ref. [14].

employing frequency hopping, a single channel mode for use with radios that don't employ frequency hopping, and as an airborne relay in the ECCM or non-ECCM mode [Ref. 16]. Additionally, SINCGARS can be configured for manportable, vehicle, or aircraft use. [Ref. 14] SINCGARS interfaces with Mobile Subscriber Equipment, current FM radios, JTIDS, and some NATO single channel radios.

3. The Area Common User System (ACUS)

Mobile Subscriber Equipment (MSE) is a multipurpose system providing secure voice, data, and fax communications for fixed and mobile subscribers [Ref. 15]. MSE is most often compared to a commercial cellular phone system. The system uses a network of nodes throughout the area of operations to provide connectivity between Mobile Subscriber Radio Terminals (MSRT), Digital Nonsecure Voice Terminals (DNVT), and Nonsecure Facsimile Terminals. MSE provides increased mobility because the communication system is not part of a command post (that is inaccessible while on the move); calls are switched through the network to MSRTs and DNVTs mounted in command and staff vehicles. [Ref. 14] MSE interfaces with commercial systems, SINCGARS, multichannel satellite systems, and other NATO systems.

D. THE BATTLEFIELD FUNCTIONAL AREA CONTROL SYSTEMS

1. The All Source Analysis System (ASAS)

ASAS is the BFACS controlling the Intelligence BOS. It is a ground-based automated system designed to give intelligence and targeting support to commanders. ASAS uses communications and fusion capabilities to put sensor and other intelligence data into a single database to be simultaneously available to multiple users at separate workstations. [Ref. 21] ASAS is also capable of extracting information from national level databases.

Table 5 summarizes some of ASAS's capabilities.

2. The Maneuver Control System (MCS)

MCS is the BFACS controlling the Maneuver BOS. MCS uses CHS to display and distribute critical tactical battlefield information for commanders. Display capabilities provide commanders with decision support aids including current situation reports, intelligence reports, enemy contact reports assessing enemy strength and movements, and reports detailing status of friendly forces. These decision support aids can then be used to produce and distribute critical tactical battlefield information such as courses of action, Warning Orders (WARNORDS), Operations Orders (OPORDS), and priorities of work. Additionally, MCS can request intelligence, supply status, air operations, and fire support information from other BFACS. Another MCS capability includes decision graphics commonly found in a maneuver Tactical Operations Center (TOC). These overlays include the basic scheme of maneuver, enemy disposition, air defense plan, fire support plan, intel/electronic warfare plan, signal support plan, engineer obstacle plan, NBC, and CSS. Included in the overlays are unit resource information (combat potential) that allow

ASAS FUNCTIONAL CAPABILITIES	
Function	Capabilities
Database	<ul style="list-style-type: none"> - Automatic correlation of intelligence information to create an all source database. - Event alarms based on certain database updates that triggers auto-retrieval of information for other applications. - Timer-base queries.
Situation Display	<ul style="list-style-type: none"> - Friendly/enemy databases. - Interactive tools to support threat integration, collection management, battle damage assessment, and force protection.
Situation/Event Planning	<ul style="list-style-type: none"> - Auto-notification of threat and high interest events. - Displays areas of interest, trafficability areas, avenues of approach, and mobility corridors.
Target Planning	<ul style="list-style-type: none"> - Creates and maintains target databases. - Alarms for high priority high value targets.
Message Dissemination	<ul style="list-style-type: none"> - Automatic message parsing and routing. - Automatic message generation and release. - Interactive message generation, edit, and review.

Table 5. All Source Analysis Capabilities. After Ref. [22].

commanders and staff to develop courses of action, WARNORDs, OPORDs, and appropriate annexes for distribution. As part of the ATCCS, MCS uses the Communications Hub to provide commanders at all levels with a common operational picture of the battlefield that facilitates synchronization. [Ref. 18]

3. The Advanced Field Artillery Tactical Data System (AFATDS)

AFATDS is the BFACS controlling the Fire Support BOS. AFATDS uses CHS to coordinate and process fire missions in support of the commander's scheme of maneuver. In doing so, AFATDS optimizes use of all fire support assets such as mortars, field artillery, cannon, missile, attack helicopter, close air support, naval gunfire, and offensive electronic warfare. AFATDS software attempts to satisfy a fire mission by identifying the most

effective weapon system available at the lowest echelon to defeat a target. It also takes into account information received from MCS on target priorities and commander's guidance. Display capabilities include graphical representation of fire support assets and combat potential. [Ref. 19] AFATDS also manages and displays five critical field artillery functional areas: fire support planning, fire support execution, field artillery movement control, field artillery mission support, and field artillery fire direction operations. Table 6 summarizes the capabilities under each field artillery functional area.

As does MCS, AFATDS uses the Communications Hub as the data transport means to provide commanders at all levels with a common picture of fire support assets and capabilities. [Ref. 20]

4. The Forward Area Air Defense Command, Control and Intelligence System (FAAD C²I)

FAAD C²I is the BFACS controlling the Air Defense BOS. It is the C² system that integrates airspace with the battlefield. It is also a system of systems in that it integrates capabilities from sensors, weapons, and C² systems to warn and protect ground forces from low-altitude air attack. The FAAD C²I information flow from sensor to shooter occurs as follows: FAAD C²I uses JTIDS to receive long-range enemy air information from AWACS aircraft and passes it to the Division TOC and FAAD Battalion. That information (along with AWACS C² information) is passed via SINCGARS to C² nodes where it is combined with local air track information. This combined air picture is further disseminated (again via SINCGARS) throughout the FAAD Battalion and down to individual FAAD weapon systems for engagement. This process occurs near-real time as a result of the

FIELD ARTILLERY FUNCTIONAL AREAS	
Functional Area	Functions/Capabilities
Fire Support Planning	<ul style="list-style-type: none"> - Develop fire support planning guidance. - Develop fire support plans. - Determine commander's concept of operations. - Develop and monitor FA logistic support plan. - Determine target acquisition capabilities. - Coordinate meteorological operations.
Fire Support Execution	<ul style="list-style-type: none"> - Process targets. - Report FA status. - Analyze FA attack systems. - Analyze and perform Target Damage Assessment (TDA) - Develop order to fire. - Prepare order to fire. - Conduct FA sensor operations.
Movement Control	<ul style="list-style-type: none"> - Control fire support movement. - Control FA movement. - Prepare FA movement requests.
Field Artillery Fire Direction Ops	<ul style="list-style-type: none"> - Determine firing unit capabilities. - Process fire missions. - Report fire mission status.
Field Artillery Mission Support	<ul style="list-style-type: none"> - Control FA supplies. - Control FA maintenance. - Control FA personnel.

Table 6. The Field Artillery Functional Areas. After Ref. [20].

Communications Hub capabilities of ATCCS. [Ref. 22]

5. The Combat Service Support Control System (CSSCS)

CSSCS is the BFACS controlling the Combat Service Support BOS. It consolidates all admin and logistic related information from other Standard Army Management Information Systems (STAMIS) to give commanders information such as ammunition levels, fuel supplies, personnel (admin and finance) status, transportation and maintenance services, and general supply levels. Recalling a point made in Chapter II about factors affecting trends in technology; the CSSCS is a prime example of how the increased pace of combat

operations required development of a system to handle the enormous amount of information required to plan operations. Manual systems cannot keep pace with rapidly changing events on the battlefield. CSSCS provides commanders the capability to quickly access near real-time information to determine their unit's combat potential. Additional capabilities include the ability to do trade-off analysis (based on resupply capability information) to develop different courses of action. CSS commanders may also use the CSSCS to manage and plan courses of action for their own units. [Ref. 23]

E. SUMMARY

This chapter familiarized the reader the Army Tactical Command and Control System. It provided an introduction to the components and capabilities of the ATCCS by discussing the hardware and communications hub that supports the ATCCS. Additionally this chapter took the seven Battlefield Operating Systems (BOSs) and showed the reader how those BOSs are the basis for the five Battlefield Functional Area Control Systems (BFACS) of the ATCCS. Finally, this chapter outlined the capabilities of the five BFACS of the Army Tactical Command and Control System.

This chapter concludes the summary of critical information for the reader. It is the last chapter that *familiarizes* the reader with C⁴I doctrine and ATCCS, and as such, finishes the information base for the final chapter. Throughout other chapters, reference was made to relationships between the doctrine at different levels, and how systems that implement that doctrine will improve the way we fight, both joint, and as a single Service. The next and final chapter turns that *information base* into a *knowledge base* by clearly identifying the threads of continuity from joint doctrine through Army doctrine and into implementation in

the Army Tactical Command and Control System. It is the final step in accomplishing the purpose of this thesis.

VI. THE THREADS OF CONTINUITY

The last chapter familiarized the reader with the Army Tactical Command and Control System. It gave the reader an introduction to the components and capabilities of the ATCCS. It was the last chapter that summarized critical information for the reader. Throughout the chapters leading to this final chapter, reference is made to relationships between the doctrine at different levels and how systems that implement that doctrine will improve the way we fight. This final chapter takes the summarized information and clearly identifies the threads of continuity from joint doctrine through Army doctrine and into implementation in the Army Tactical Command and Control System. Some of the threads are clearly identifiable in the text of joint and Army doctrine and others are more abstract but, none the less, there. The author categorizes and identifies three types of threads:

- Common Threads in Tone. This section validates that the guiding C⁴I documents discussed in this thesis are written in a tone commensurate with the definition of doctrine.
- Common Threads in Objective. Recall from Chapter II that at the joint level, the role and objectives of C⁴ systems are supported by the Basic C⁴ Principles. This section shows the reader how the fundamental objective of C⁴ systems outlined at the joint level is *also* supported by principles at the next lower level: The Enterprise Strategy Principles.
- Common Threads in Guidance. This section validates that principles outlined at the joint level are carried through the Army level, and that there is evidence of implementation of those principles in ATCCS.

Identifying threads of continuity is the final step in achieving the thesis purpose.

A. COMMON THREADS IN TONE

The first thread of continuity is seen in the way Joint Pub 6-0 and the Army

Enterprise Strategy are written: *in the form of doctrine*. This is to say that Joint Pub 6-0 and The Army Enterprise Strategy are written with respect to the definition of what doctrine is, and that like a chain of command, Army doctrine is supportive and falls under the authority of joint doctrine. This is not to say that The Army Enterprise Strategy is accepted as doctrine, just that it guides the actions of the Army C4I Community much like doctrine.

Recall from Chapter II that doctrine as defined by Joint Pub 1.02 is:

Fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgement in application. [Ref. 1]

Similar definitions are cited for Army, Combined, Joint, and Multi-Service Doctrine leading to three conclusions:

- The term "...fundamental principles...that guide their actions...." exists in every definition. This is the essence of doctrine that makes it the cornerstone for how the Services fight alone and together.
- Doctrine provides a common approach to operations for those it applies to [Ref. 3].
- The last sentence, explicitly stating the balance between authority and judgement, is stated or implied in all the definitions.

Both Joint Pub 6-0 and The Enterprise Strategy delineate the need for doctrine and the three conclusions above can be drawn about the guidance found in each publication.

The clearest example of where both publications are "...fundamental principles...that guide their actions...." is seen in the Basic C⁴ System Principles in Joint Pub 6-0, and The Enterprise Strategy Principles. In the case of Joint Pub 6-0, the Basic C⁴ System Principles are the *fundamental guidance* for how C⁴ systems must operate to support joint operations. Additionally, the principles serve to *focus the actions* of the Services when stating

requirements for the design, development, and procurement of C⁴ systems. In the case of The Army Enterprise Strategy, The Principles are the *fundamental guidance to focus the actions* of the Army C⁴I community to ensure information dominance that will win the battlefield information war. As with Joint Pub 6-0, The Army Enterprise Strategy is clear in stating what to do, but not how to do it; both documents leave room for *judgement in application*. A final point refers to the authoritative nature of Joint Pub 6-0 and The Army Enterprise Strategy: both are endorsed by the ranking military officer at that level, the Chairman of The Joint Chiefs of Staff for Joint Pub 6-0 and the Army Chief of Staff for The Army Enterprise Strategy. There is no room left for misunderstanding as to whether or not these publications are to be followed.

B. COMMON THREADS IN OBJECTIVE

Recall from Chapter II that Joint Pub 6-0 states that the fundamental objective of C⁴ systems is to get the critical and relevant information to the right place at the right time [Ref. 4]. This fundamental objective is supported by all but three of The Enterprise Strategy Principles.

1. Focus On The Warfighter

This first Enterprise Strategy Principle identifies five challenges that carry the common thread in objective:

- Challenge One: Provide a responsive requirements process that reflects warfighter's needs [Ref. 6].
- Challenge Two. Provide soldier friendly systems [Ref. 6].
- Challenge Three. Provide more deployable systems [Ref. 6].

- Challenge Four. Provide capable and reliable systems [Ref. 6].
- Challenge Five. Provide systems that function in both garrison and tactical environments [Ref. 6].

These five challenges describe a hierarchical approach to providing one C⁴I system (Challenge Five) that the warfighter needs (Challenge One), can easily use (Challenge Two), can take anywhere (Challenge Three), and will work wherever they take it (Challenge Four). Meeting these challenges will surely facilitate getting the critical and relevant information to the right place at the right time.

2. Ensure Joint Interoperability

This second Enterprise Strategy Principle carries the common thread in objective by identifying the need for systems that are not hindered by joint interoperability barriers. Recall from Chapter II that interoperability is essential to mission success in joint and combined operations. Joint doctrine does not expect the Army to fight alone and neither does Army doctrine:

The Army does not fight alone. It integrates its efforts in unified operations with its sister services, with other national agencies, and often with allied and coalition forces. By doing so, the Army's operational capabilities are enhanced, victory comes quicker, and friendly casualties are reduced. [Ref. 3]

For Services to fight together, they must be able to communicate and pass information with *no intermediate processing*. A C⁴I system that is interoperable will surely facilitate getting the critical and relevant information to the right place at the right time.

3. Digitize the Battlefield

This third Enterprise Strategy Principle carries the common thread in objective by

identifying the need for a battlefield network that optimizes the transfer of information to provide a Common Operational Picture (COP). The COP is a joint concept whereby commanders, staff, and their soldiers, sailors, or marines have a “common picture” of the battlefield at the same time on one terminal device. It could be viewed as the epitome of presenting the right information at the right place at the right time.

4. Capitalize on Space Based Systems

This fourth Enterprise Strategy Principle carries the common thread in objective by identifying the need to make use of space based assets. Providing communications to remote areas, a power-projection Army conducting split-based operations, and the dependence on commercial satellites to augment overloaded military satellites are all issues that require getting the right information in a timely manner.

5. Modernize Power Projection Platforms

This fifth Enterprise Strategy Principle carries the common thread in objective by identifying the need to modernize power projection platforms. The CONUS based installations are the power projection platforms for today’s Army. Modernizing them supports split-based operations. As with exploiting space based assets, our installations must be as capable as the C⁴I systems that they support in the field. Anything less does not facilitate timely transfer of the right information to soldiers in the field - it falls short at the support base.

6. Implement Multi-Level Security

This sixth Enterprise Strategy Principle carries the common thread in objective by identifying the need to implement multi-level security. An MLS system provides a single

system that can do many functions without degrading capability. It allows users at different sensitivity (classification) levels to access one system at the same time and/or one user to access different sensitivity levels at the same time on one system. In the absence of such a system, a soldier may have to access information of different sensitivity levels on different systems. The systems may even be physically or geographically separated; this is not conducive to transfer of timely and critical information. Multi-level security is a clear supportive principle of the fundamental objective of C⁴ systems.

7. Ensure Spectrum Supremacy

This seventh Enterprise Strategy Principle carries the common thread in objective by identifying the need to ensure spectrum supremacy. Advances in C⁴I technology allow the Army to enhance warfighting capabilities, but the systems cannot operate without continuous and uninterrupted use of the electromagnetic spectrum. This Enterprise Strategy Principle calls for a single authority within a task force responsible for the spectrum, and active participation in policy formulation. Additionally, information warfare and coordination will increase the likelihood of success in this area. This principle supports the fundamental objective of C⁴ systems in that any degradation of the Services' ability to use the spectrum affects the timely transport of information. Table 7 summarizes the fundamental objective of joint C⁴ systems' support to joint operations and its Enterprise Strategy Principles that carry that common thread.

C. COMMON THREADS IN GUIDANCE

Recall from Chapter II that the Basic C⁴ System Principles found in Joint Pub 6-0 support the fundamental objective of C⁴ systems, also found in Joint Pub 6-0. This makes

SUMMARY OF COMMON THREADS IN OBJECTIVE	
Fundamental Objective of objective of C ⁴ systems as stated in Joint Pub 6-0.	Enterprise Strategy Principles that carry the common thread in objective.
The fundamental objective of C ⁴ systems is to get the critical and relevant information to the right place at the right time [Ref. 6].	Focus on the Warfighter Ensure Joint Interoperability Digitize the Battlefield Capitalize on Space Based Systems Modernize Power Projection Platforms Implement Multi-Level Security Ensure Spectrum Supremacy

Table 7. The Fundamental Objective of C⁴ Systems and Supporting Enterprise Strategy Principles.

sense because both the objective and principles exist as doctrine at the same level. This section validates that those principles outlined at the joint level are carried through the Army level, and that there is evidence of implementation of those principles in ATCCS. As in the previous section, the author takes doctrine from the joint level (Basic C⁴ System Principles in this case) and identifies the supporting Enterprise Strategy Principles.

1. **Interoperable**

This first Basic C⁴ System Principle is supported by the second Enterprise Strategy Principle of Ensuring Joint Interoperability. Its implementation is in the Communications Hub, and the Common Hardware and Software Concept (CHS) of ATCCS.

Joint Pub 6-0 says that joint and Service C⁴ systems must possess the interoperability necessary to ensure mission success in joint and combined operations. It further states that interoperability is the condition achieved among C⁴ systems or items of C⁴ equipment when

information or services can be exchanged *directly* and *satisfactorily* between them and their users [Ref. 4]. The Army Enterprise Strategy supports the joint principle by saying that in order for Services to fight together, they must be able to communicate and pass information with no intermediate processing. Furthermore, under the principle of interoperability at the joint level are the concepts of commonality, compatibility and standardization. The Enterprise Strategy Principle of Ensuring Joint Interoperability implies the importance of commonality, compatibility and standardization, concepts that promote interoperability:

Interoperability encompasses doctrine, procedures, and training - as well as systems and equipment ... Achieving interoperability will require adherence to industry standards for engineering, communications protocols, and data elements. Standards define a common environment in which new systems can be introduced at reduced risk. [Ref. 6]

The implementation of the principle of interoperability and the supporting concepts of commonality and standardization are seen in the Communications Hub, and Common Hardware and Software Concept (CHS) of ATCCS. The Communications Hub uses components of the Army Data Distribution System, Combat Net Radios, and Area Common User System to pass information to the other Services. Those components, such as EPLRS, JTIDS, MSE, and SINCGARS used singly and in combination, are the practical implementation of interoperability. The CHS concept is the practical implementation of commonality and standardization. Recall that for equipment to be common, personnel trained on other (similar) equipment can operate and maintain it with no additional specialized training. Commonality also means interchangeability of repair parts and consumable items. [Ref. 4] This is clearly seen in the CHS concept where the five BFACS all use the same hardware. Equipment is standardized when it includes aspects of

commonality and interoperability. An example of standardization is seen in the use of MSE, JTIDS, and SINCGARS, all used as part of the Communications Hub of ATCCS, and their use in all three of the other Services. Although operational requirements of the different Services limit the equipment in size, weight or other physical characteristics, there are aspects of standardization indicating cooperation among the Services. The three classes of JTIDS terminals in Table 4 are an example. Table 8 summarizes the common thread in principle, interoperability.

SUMMARY OF COMMON THREAD IN PRINCIPLE (INTEROPERABLE)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Interoperable	Ensure Joint Interoperability	Communications Hub of ATCCS
Interoperable (Standardization)		Common Hardware and Software Concept
Interoperable (Commonality)		

Table 8. Summary of Common Thread in Principle (Interoperable).

2. Flexible

This second Basic C⁴ System Principle is supported by four of the Enterprise Strategy Principles. They are Ensuring Joint Interoperability, Digitize the Battlefield, Capitalize on Space Based Systems, and Acquire Integrated Systems Using Commercial Technology. Again, the implementation is evident in the Communications Hub, and the Common Hardware and Software Concept (CHS) of ATCCS.

Recall that Joint Pub 6-0 describes flexibility as a concept whereby C⁴ systems are

designed and operated in a way that allows for rapid integration of equipment between separate units and *is achieved* through the use of standardized design, commercial off the shelf (COTS) components and standards, commercial facilities, mobile and transportable systems, and pre-positioned facilities [Ref. 4]. The common threads are seen in the concept of flexibility and in how flexibility is achieved.

Digitizing the Battlefield is the Enterprise Strategy Principle that best supports the concept of flexible systems that are designed and operated in a way that allows for rapid integration of equipment between separate units. This principle achieves flexibility, in concept, by providing a common protocol for systems and transmission media that facilitates flexibility.

Achieving flexibility through standardized design of equipment is supported by the Enterprise Strategy Principle of Ensuring Joint Interoperability and specifically, the concept of standardization that supports the principle of interoperability (the reader can refer back to the section above on Interoperability).

Achieving flexibility through use of commercial off the shelf (COTS) components and standards is supported by the Enterprise Strategy Principle of Acquiring Integrated Systems Using Commercial Technology. The Enterprise Strategy Principle of Acquiring Integrated Systems Using Commercial Technology supports the Basic C⁴ System Principle of Flexibility by acknowledging that the commercial sector is the leader in information and C⁴I systems technology, and the generation of new technology happens quicker than the acquisition cycle allows the Services to buy it. The Enterprise Strategy calls for the Army to affect the streamlining of the acquisition cycle, work with industry to influence new

technology development and standardization, exploit current emerging technology, and only resort to Army-funded technology when necessary [Ref. 6]. By working with industry, the Services can enhance flexibility in emerging systems and systems will advance in an evolutionary manner rather than developing new systems [Ref. 6].

Achieving flexibility through use of commercial facilities is reflected by the Enterprise Strategy Principles of Capitalize on Space Based Systems. This Enterprise Strategy Principle calls for increased use of commercial satellites to decrease overload on military satellites. It also calls for initiatives to establish procedures to allow more ease of access to commercial satellites. Those initiatives will address issues such as interoperability, security and rights of usage and thereby enhance flexibility.

The implementation of flexibility is evident in the Communications Hub, and the Common Hardware and Software Concept (CHS) of ATCCS. EPLRS in the Communications Hub can use commercial satellites to forward grid reference to other EPLRS users, and MSE can interface with commercial switches to enter into the commercial telephone system. Referring back to Table 3, Characteristics of Hardware in the CHS, in Chapter V, the reader will see that the various computing units are all based on commercial CPUs. Table 9 summarizes the common thread in principle, flexibility.

3. Responsive

The third Basic C⁴ System Principle is supported by eight of the Enterprise Strategy Principles. They are Focus on the Warfighter, Ensure Joint Interoperability, Digitize the Battlefield, Capitalize on Space Based Systems, Modernize Power Projection Platforms, Implement Multi-Level Security, Ensure Spectrum Supremacy, and Acquire Integrated

SUMMARY OF COMMON THREAD IN PRINCIPLE (FLEXIBLE)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Flexible	Digitize The Battlefield	Common Hardware and Software Concept Communications Hub
Flexible (through use of standardized design)	Ensure Joint Interoperability (standardization)	Common Hardware and Software Concept
Flexible (through use of COTS)	Acquire Integrates Systems Using COTS	Communications Hub of ATCCS (EPLRS, MSE)
Flexible (through use commercial facilities)	Capitalize on Space Based Systems (use of commercial satellites)	Communications Hub of ATCCS (EPLRS, MSE)

Table 9. Summary of Common Thread in Principle (Flexible).

Systems Using Commercial Technology. Again, the implementation is evident in the Communications Hub, and the Common Hardware and Software Concept (CHS) of ATCCS.

Recall that Joint Pub 6-0 describes responsive systems as reliable, redundant, and timely. They must be available when needed and must perform as intended; provide alternate paths, and back-up systems; and reduce processing and transmission time for warning, critical intelligence, and operation order execution.

The concept of reliability under the Basic C⁴ System Principle of responsive is supported by the fourth challenge under the Enterprise Strategy Principle of Focus on The Warfighter. It says that the Army must provide their soldiers with capable and reliable systems and provides the Louisiana Maneuvers Decision Making Process as a means for expediting requirements sent from the field. Recall that what is capable and reliable is still a function of the soldier's clear articulation of what constitutes capable and reliable.

The concepts of redundancy and timeliness are supported by the Enterprise Strategy Principles of Ensure Joint Interoperability, Digitize the Battlefield, Capitalize on Space Based Systems, Modernize Power Projection Platforms, Ensure Spectrum Supremacy, and Acquire Integrated Systems Using Commercial Technology. Joint interoperability facilitates the concept of alternate paths, back-up systems, and reduced processing and transmission time by providing multiple systems that communicate directly between Service units. The digitized battlefield provides a common network protocol for rapid integration of equipment between separate units. Space based systems and integrated COTS technology provide fast, alternate paths. Modernized installations must encompass all of this. Finally, techniques and doctrine to ensure spectrum supremacy facilitates reliability, redundancy, and timeliness. Table 10 summarizes the common thread in principle, responsive.

4. Mobile

The fourth Basic C4 System Principle is supported by of the Enterprise Strategy Principle of Focus On The Warfighter and its implementation is evident in the Common Hardware and Software Concept.

Mobile systems are designed to compliment the mobility of the forces they support. Challenges Three and Five under Focus On The Warfighter state that more deployable systems that function in both garrison and tactical environments are fundamental to the warfighters' ability to accomplish the combat mission. They must have systems as compact and mobile as they are, that reduce training requirements and time required for transition from peace to war.

The implementation is most evident in the CHS Concept. Table 3 in Chapter V

SUMMARY OF COMMON THREAD IN PRINCIPLE (RESPONSIVE)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Responsive (Reliable)	Focus on the Warfighter (Challenge Four)	
Responsive (Redundant)	Ensure Joint Interoperability Digitize the Battlefield Capitalize on Space Based Systems	Common Hardware and Software Concept Communications Hub
Responsive (Timeliness)	Modernize Power Projection Platforms Ensure Spectrum Supremacy Acquire Integrated Systems Using Commercial Technology	

Table 10. Summary of Common Thread in Principle (Responsive).

depicts systems small enough to fit in the palm up to large processors for fixed-location use. Although all the hardware pieces do not have the same capability, they do have the capabilities anticipated for use in specific tactical situations. Table 11 summarizes the common thread in principle, mobile.

SUMMARY OF COMMON THREAD IN PRINCIPLE (MOBILE)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Mobile	Focus On The Warfighter (Challenge Three and Five)	Common Hardware and Software Concept

Table 11. Summary of Common Thread in Principle (Mobile).

5. Disciplined

The fifth Basic C⁴ System Principle is supported by the Enterprise Strategy Principle

of Ensure Spectrum Supremacy. There is no evident implementation in ATCCS since discipline is more a function of asset management than system design.

A disciplined system is less a function of system design and more an issue of asset management. C⁴ systems possess finite capabilities and are a limited resource on the battlefield; commanders must manage the frequencies along functional lines (e.g. admin, logistics, operational) and in accordance with international and host nation communication laws. The Enterprise Strategy supports this principle by calling for two actions: a single authority responsible for spectrum management and active participation in policy formulation. Table 12 summarizes the common thread in principle, disciplined.

SUMMARY OF COMMON THREAD IN PRINCIPLE (DISCIPLINED)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Disciplined	Ensure Spectrum Supremacy	None

Table 12. Summary of Common Thread in Principle (Disciplined).

6. Survivable

The sixth Basic C4 System Principle is supported by the Enterprise Strategy Principles of Focus On The Warfighter, and Implement Multilevel Security. The implementation is evident in the Common Hardware and Software Concept.

C⁴ systems are the lifeblood of command centers and must be survivable. Part of the survivability of a system and its data relies on hardening of equipment, operations security measures (OPSEC), communications security measures (COMSEC), and software protection measures such as user access controls (passwords), intrusion detection software, viral

detection software, or a combination of these. The Enterprise Strategy Principle of Focus On The Warfighter, Challenge Four, implies survivability when it says that soldiers will decide what a reliable system is. The system users are best equipped to say how ruggedized a system must be. The issues of OPSEC, COMSEC, and software protection measures are all addressed by The Enterprise Strategy Principle of Implement Multilevel Security by making the point that though information at many levels *can* be accessed, it can only be accessed by a user authorized to access it. Although MLS, alone, won't prevent an inside user from tampering with software or data, it may compartmentalize their ability to do so based on security levels.

The implementation is evident in the Common Hardware and Software Concept: all systems are hardened and MLS is implemented in the ASAS BFACS. Table 13 summarizes the common thread in principle, survivable.

SUMMARY OF COMMON THREAD IN PRINCIPLE (SURVIVABLE)		
Basic C ⁴ System Principle (Joint Pub 6-0)	Supporting Enterprise Strategy Principles (Army Enterprise Strategy)	Evidence of Implementation (ATCCS)
Survivable	Focus On The Warfighter Implement Multilevel Security	Common Hardware and Software Concept

Table 13. Summary of Common Thread in Principle (Survivable).

7. Sustainable

The final Basic C⁴ Principle anchors the principles themselves. Sustainability, in this context, means "continuous support during any type and length of joint operation." [Ref. 4] It is the single principle that specifically addresses *continuous* and *uninterrupted* flow and

processing of information. It is supported by the Enterprise Strategy Principles of Optimize The Information Technology Environment and Acquire Integrated Systems Using Commercial Technology. The implementation is seen in the CSSCS BFACS.

Recall from Chapter II that inherent in sustainment operations is the training and employment of maintenance personnel, system-specific logistics requirements like spare parts, and expendable supplies. A C⁴ system that has the attributes of all the other principles, but lacks sustainability, defeats the purpose of the principles as a whole. The Enterprise Strategy Principle of Optimize The Information Technology Environment supports the final Basic C⁴ System Principle in its call for maximum use of standardization and commonality; this facilitates sustainability even in an area where technology improves so rapidly.

Finally, Acquiring Integrated Systems Using Commercial Technology supports the Basic C⁴ System Principle of sustainability in effect, by trying to exploit technology trends, streamlining the acquisition cycle, working with industry to influence new technology development and standardization, exploiting current emerging technology, and only resort to Army-funded technology when necessary. The benefits of implementing this principle are cost savings due to the reduced price of technology and an increased availability of maintenance parts based on commercial demands. Additional benefits, as in the commercial sector, will come in the form of incremental upgrades and technology add-ons rather than developing all new systems.

The implementation is seen in the CSSCS BFACS. Part of its many functions include giving commanders information on maintenance services, and general supply levels. This is the sustainment function that supplements the command function of ATCCS.

D. SUMMARY

Recall that the purpose of this thesis was to supplement the Joint C⁴I Curriculum by strengthening the C⁴I knowledge base of Army officers entering the curriculum. The author intended to familiarize the reader with doctrinal C⁴I principles, show the reader how Army operational doctrine affected the functional design of ATCCS, ATCCS capabilities, and draw some threads of continuity from joint doctrine through Army guidance into implementation in ATCCS. The first five chapters familiarized the reader with doctrinal C⁴I principles, operational doctrine affecting the functional design of ATCCS, and ATCCS capabilities. They provided the reader with the information base necessary to draw the threads of continuity. This final chapter completes the purpose of the thesis by identifying Common Threads in Tone, Common Threads in Objective, and Common Threads in Guidance.

The Common Threads in Tone showed the reader that both Joint Pub 6-0 and The Army Enterprise Strategy are written in a tone commensurate with the definition of doctrine. The Common Threads in Tone showed the reader that both publications contain “...fundamental principles...that guide actions....” as seen in the Basic C⁴ System Principles in Joint Pub 6-0, and The Enterprise Strategy Principles.

The Common Threads in Objective showed the reader how the fundamental objective of C⁴ systems, outlined at the joint level, is *also* supported by principles at the next lower level: The Enterprise Strategy Principles. These threads of continuity showed the reader that the guidance found in The Army Enterprise Strategy are supportive, and complementary to the doctrine found in Joint Pub 6-0. Additionally, they show that the Army Enterprise Strategy falls under the authority of Joint Pub 6-0.

The Common Threads in Guidance showed the reader that the principles (in joint doctrine) that guide the joint C⁴I community are carried through in the guidance (at Army level) that focuses the Army C⁴I community. Finally, these threads of continuity showed the reader where there is evidence of implementation of those principles in ATCCS.

This final chapter completes the purpose of the thesis.

LIST OF REFERENCES

1. Joint Chiefs of Staff, Department of Defense Dictionary of Military and Associated Terms, Joint Publication 1-02, Washington DC, 23 March 1994.
2. Coakley, T.P., Command and Control for War and Peace, National Defense University Press, Washington DC, 1992.
3. Department of the Army, Operations, Army Field Manual 100-5, Washington DC, 14 June 1993.
4. Joint Chiefs of Staff, Joint Publication 6-0, Doctrine for Command, Control, Communications, and Computer (C⁴) Systems Support to Joint Operations, Washington DC, 30 May 1995.
5. Bjorklund, R. C., The Dollars and Sense of Command and Control, National Defense University Press, Washington DC, 1995.
6. Office of the Secretary of the Army, The Army Enterprise Vision, Director of Information Systems for Command, Control, Communications, and Computers (C⁴), Washington DC, 20 July 1993.
7. Office of the Chief of Staff of the Army, Louisiana Maneuvers, Director, Louisiana Maneuvers Task Force, Washington DC, 1 March 1994.
8. Gangemi, G. T., and Russell, D., Computer Security Basics, O'Reilly & Associates, Inc., Sebastopol, California, July 1992.
9. Office of the Secretary of the Army, The Army Enterprise Implementation Plan, Director of Information Systems for Command, Control, Communications, and Computers (C⁴), Washington DC, 8 August 1994.
10. Hughes, Wayne, Jr., Command and Control Within The Framework of a Theory of Combat, pp. 1-16, Presentation to the AIAA C³ Symposium, Naval Postgraduate School, June 1992.
11. Department of the Army, Common Hardware/Software, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
12. Defense Technical Information Center, Win The Information War, Weapon Systems, Common Hardware and Software, <http://www.dtic.mil/deselink/pubs/armyfact/chs.html>, Defense Technical Information Center Headquarters, Fort Belvoir, Virginia, 1 May 1997.

13. Department of the Army, ACCS, Command and Control for Today's Battlefield, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
14. C⁴I Integration Support Activity, C⁴I Handbook For Integrated Planning, Defense Investigative Agency Publications, Washington D.C., May 1996.
15. Department of the Army, Communications, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
16. Kim, J. C., and Muehldorf, E. I., Naval Shipboard Communications Systems, Prentice Hall PTR, Englewood Cliffs, New Jersey, 1995.
17. Department of the Navy, Naval Doctrine Publication 6, Naval Command and Control, Washington D.C., 19 May 1995.
18. Department of the Army, Maneuver Control System, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
19. Department of the Army, Advanced Field Artillery Tactical Data System, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
20. U.S. Army Communications-Electronics Command-New Equipment Training Team-Advanced Field Artillery Tactical Data Systems, Advanced Field Artillery Tactical Data System, <http://sill-www.army.mil/cecom/CNAFATDS.HTM>, Fort Sill, Oklahoma, 73501-0241, 1 May 1997.
21. Department of The Army, Army Digitization Master Plan '96, <http://www.ado.mil/admp/1996/05abcs.html>, Army Digitization Office, 200 Army Pentagon, Washington D.C., 20310-0200, 1 May 1997.
22. Department of the Army, Forward Area Air Defense Command, Control and Intelligence System, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
23. Department of the Army, Combat Service Support Control System, Fact Sheet, Program Executive Office, Command and Control Systems, Fort Monmouth, New Jersey, 1994.
24. Department of the Army, ACCS Command & Control For Today's Battlefield, Program Executive Office, Command & Control Systems, Fort Monmouth, NJ, 1996.
25. Department of the Army, Information Management, Army Field Manual 25-1, Washington, D.C., 25 March 1997.

APPENDIX A. GLOSSARY OF TERMS

Combined Doctrine. Fundamental principles that guide the employment of forces of two or more nations in coordinated action toward a common objective. It is ratified by participating nations. [Ref. 1]

Command. The authority that a commander in the Armed Forces lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. [Ref. 1]

Command and Control. The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. [Ref. 1]

Command, control, communications, and computer systems. Integrated systems of doctrine, procedures, organizational structures, personnel, equipment, facilities, and communications designed to support a commander's exercise of command and control across a range of military operations. Also called C⁴ systems. [Ref. 1]

Command and Control System. The facilities, equipment, communications, procedures, and personnel essential to a commander for planning, directing, and controlling operations of assigned forces pursuant to the missions assigned [Ref. 1].

Commonality. A quality that applies to materiel or systems: a. possessing like and interchangeable characteristics enabling each to be utilized, or operated and maintained, by personnel trained on the others without additional training. b. Having interchangeable repair parts and/or components. c. applying to consumable items interchangeable equivalent without adjustment.

Communications. A method or means of conveying information of any kind from one person or place to another. [Ref. 1]

Compatibility. Capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference.

Control. Authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations [Ref. 1].

Doctrine. Fundamental principles by which military forces guide their actions in support of national

objectives. Doctrine is authoritative but requires judgement in application. [Ref. 3]

Doctrine. Fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgement in application. [Ref. 1]

Fusion. In intelligence usage, the process of examining all sources of information and intelligence to derive a complete assessment of activity [Ref. 1].

Interoperability. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. [Ref. 1]

Joint Doctrine. Fundamental principles that guide the employment of forces of two or more Services in coordinated action toward a common objective. It will be promulgated by the Chairman of the Joint Chiefs of Staff, in coordination with the combatant commands, Services, and Joint Staff. [Ref. 1]

Multi-Service Doctrine. Fundamental principles that guide the employment of forces of two or more Services in coordinated action toward a common objective. It is ratified by two or more Services, and is promulgated in multi-Service publications that identify the participating Services, e.g. Army-Navy doctrine. [Ref. 1]

Standardization. The process by which the Department of Defense achieves the closest practicable cooperation among the Services and Defense agencies for the most efficient use of research, development, and production resources, and agrees to adopt on the broadest possible basis the use of: a. common or compatible operational, administrative, and logistic procedures; b. common or compatible technical procedures and criteria; c. common, compatible, or interchangeable supplies, components, weapons, or equipment; d. common or compatible tactical doctrine with corresponding organizational compatibility. [Ref. 1]

Sustainability. The ability to maintain the necessary level and duration of operational activity to achieve military objectives. Sustainability is a function of providing for and maintaining those levels of ready forces, materiel, and consumables necessary to support military effort.

APPENDIX B. ACRONYMS AND ABBREVIATIONS

Appendix B is a list of acronyms and abbreviations taken from Army Regulation 25-1, Information Management [Ref. 25].

AACR	Anglo-American Cataloging Rules
AAE	Army Acquisition Executive
AASA	Administrative Assistant to the Secretary of the Army
ABC4	American, British, Canadian, Australian (Quadripartite) (Armies)
ABC5	Army Battlefield Command System
ABC5MP	Army Battlefield Command System Master Plan
ABIC	Army Battlefield Interface Concept
AC	Army component
ACC	Architecture Control Committee
ACCS	Army Command and Control System
ACSIM	Assistant Chief of Staff for Information Management
ACP	Allied Communications Publication
ADP	automatic data processing
ADPE	automatic data processing equipment
AFARS	Army Federal Acquisition Regulation Supplement
AFIS	American Forces Information Service
AFRTS	American Forces Radio and Television Service
AIF	Army Industrial Fund
AIG	address indicating groups
AIMC	Army Information Management Council
AIMSC	Army Information Management Steering Committee
AIMWG	Army Information Management Working Group
AIPPP	Army Integrated Publishing and Printing Program
AIRMP	Army Information Resources Management Program
AIS	Automated Information Systems
AISM	Army Information Standards Management
AISTAP	Army Information Systems Threat Assessment Program
AISSP	Army Information Systems Security Program
ALA	American Library Association
ALI	American Library Institute
ALRPG	Army Long-Range Planning Guidance
AMC(U.S.)	Army Materiel Command
AMEDD	Army Medical Department
AMPE	automated message processing exchange
AMS	automatic digital network mail server
ANMCC	alternate National Military Command Center
AOC	Army Operations Center

AOCCS(U.S.)	Army Operational Command and Control System
APR	acquisition procurement requests
AR	Army regulation
ARCOM	Army Reserve commands
ARNG	Army National Guard
ARSTAF	Army staff
ASA	Assistant Secretary of the Army
ASA(CW)	Assistant Secretary of the Army (Civil Works)
ASA(FM)	Assistant Secretary of the Army (Financial Management)
ASA(I&L)	Assistant Secretary of the Army (Installation and Logistics)
ASA(M&RA)	Assistant Secretary of the Army (Manpower and Reserve Affairs)
ASA(RDA)	Assistant Secretary of the Army (Research, Development, and Acquisition)
ASARC	Army Systems Acquisition Review Council
ASD(C3I)	Assistant Secretary of Defense (Command, Control, Communications, and Intelligence)
ASD(I&L)	Assistant Secretary of Defense (Installations and Logistics)
ASD(PA)	Assistant Secretary of Defense (Public Affairs)
ASEMH	Army standard electronic mail hosts
ASI	additional skill identifier
ATC	air traffic control
ATCCS	Army Tactical Command and Control Systems
AUTODIN	automatic digital network
AUTOSEVOCOM	automatic secure voice communications
AV	audiovisual
AVIDP	Army Visual Information Documentation Program
AVIMD	Army Visual Information Management Directorate
AVIMO	Army Visual Information Management Office
AVISC	Army Visual Information Steering Committee
BAS	battlefield automation system
BECS	battlefield electronic CEOI system
BFA	battlefield functional area
BIP	budget increment package
C2	command and control
C3	command, control, communications
C3I	command, control, communications, and intelligence
C4	command, control, communications, and computers
CACDA	Combined Arms Combat Development Activity
CA/ID	control audit identifier number
CATV	cable television
CBI	computer based instruction
CCEB	Combined Communications Electronics Board
CCS	command and control system
CCS2	command and control and subordinate system

CCTV	closed circuit television
CDR	commander
CFDAD	component functional data administrator
CFR	code of Federal Regulation
CINC	Commander in Chief of Unified or Specified Command
CINCNORAD	Commander in Chief North American Air Defense
CNR	combat net radios
COB	Command Operating Budget
COMCAM	combat camera
COMDOC	combat documentation
COMINT	communications intelligence
COMPUSE	Computer security
COMSEC	communications security
CONUS	continental United States
COOP	Continuity of Operations Plan
COS	Corporation for Open Systems
COTS	commercial off-the-shelf
CPA	Chief of Public Affairs
CRITI	Critical intelligence
CRITICOM	Critical Intelligence Communications System
CSA	Chief of Staff, U.S. Army
CSS	combat service support
CTA	common table of allowances
DA	Department of the Army
DAB	Defense Acquisition Board
DARIC	Defense Automation Resources Information Center
DAS	Director of the Army Staff
DASP	Data Administration Strategic Plan
DAVIPDP	Department of the Army Visual Information Production and Distribution Program
DAVIS	Defense Automated Visual Information System
DBMS	database management system
DCID	Director of Central Intelligence
DCS	Defense Communications System
DCSIM	Deputy Chief of Staff for Information Management
DCSINT	Deputy Chief of Staff for Intelligence
DCSLOG	Deputy Chief of Staff for Logistics
DCSOPS	Deputy Chief of Staff for Operations and Plans
DCSPER	Deputy Chief of Staff for Personnel
DCTN	Defense Commercial Telecommunications Network
DDN	Defense Data Network
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency

DISC4	Director of Information Systems for Command, Control, Communications, and Computers
DISN	Defense Information Systems Network
DMATS	Defense Metropolitan Area Telephone System
DMS	Defense Message System
DOD	Department of Defense
DOIM	Director of Information Management
DPCA	Directorate of Personnel and Community Activities
DPF	Defense Processing Facility
DPI	data processing installation
DPS	Defense Printing Service
DSCS	Defense Satellite Communications System
DSN	Defense Switched Networks
DSSCS	Defense Special Security Communications System
DSSP	Defense Standardization and Specification Program
DTG	date-time group
DTS-W	Defense Telecommunications Service—Washington
DUSD(R&E)	Deputy Under Secretary of Defense (Research and Engineering)
DVI	Defense visual information
DVIAN	Department of Defense Visual Information Activity Number
EAC	echelon above corps
EC	electronic conferencing
ECP	Emergency Command Precedence
EFLBBS	Electronic Forms Library Bulletin Board
EIC	Electronic Imaging Center
ELINT	electronics intelligence
ELSEC	electronic security
EMC	electromagnetic capability
ERKEI	electronic Recordkeeping
FAR	Federal Acquisition Regulation
FCC	Federal Communication Commission
FDAD	Functional Data Administrator
FEDLINK	Federal Library Information Network
FLOT	forward line of own troops
FMS	foreign military sales
FOA	field operating agency
FOIA	Freedom of Information Act
FORSCOM	U.S. Army Forces Command
FYP	five-year plan
GENSER	general service communication system
GFC	general functional code
GOCO	Government owned, contractor operated
GOSP	General Officer Steering Panel

GPO	Government Printing Office
GPORPO	Government Printing Office regional printing procurement office
GSA	General Services Administration
HMW	health, morale, and welfare
HOL	higher order language
HQDA	Headquarters, Department of the Army
HQIM	Headquarters Department of the Army, Information Management
HUMINT	human intelligence
IAW	in accordance with
IC	information center
ICN	internal control number
IFS	integrated facilities system
ILL	interlibrary loan
ILS	integrated logistics support
ILSP	integrated logistics support plan
IMA	information mission area
IMO	information management officer
IMSC	Installation Information Management Support Council
IMWRF	Installation Morale, Welfare, and Recreation Facility
INMARSAT	Army International Maritime Satellite
INSCOM	U.S. Army Intelligence and Security Command
IP	implementation plan
IPR	in-process review
IRM	information resources management
IRMP	Information Resources Management Program
ISDN	integrated systems digital network
ISS	information system security
ISSM	information systems security managers
IT	information technology
ITU-T	International Telecommunications Union
JANAP	Joint Army-Navy-Air Force Publication
JCEOI	Joint Communications Electronics Operating Instructions
JCP	Joint Committee on Printing
JCS	Joint Chiefs of Staff
JCSE	Joint Communications Support Element
JINTACCS	Joint Interoperability of Tactical Command and Control Systems
JSC	Joint Spectrum Center
JTC3A	Joint Tactical Command, Control, and Communications Agency
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JVIS	Joint Visual Information Services
JVISCA	Joint Visual Information Services Contracting Activity
JVISDA	Joint Visual Information Services Distribution Activity

JWICS	Joint Worldwide Intelligence Communications System
LAN	local area network
LCM	life cycle management
LSR	local service request
MACOM	major Army command
MACOM/AC	Major Command/Army Component
MAISRC	Major Automated Information Systems Review Council
MARKS	Modern Army Recordkeeping System
MARS	Military Affiliated Radio System
MC/AC CCS	MACOM/Army Component Command and Control System
M/CATV	Master/Community Antenna Television
MCEB	Military Communications-Electronics Board
MCS	Maneuver Control System
MDEP	Management Decision Package
MEDCASE	medical care support equipment
MEDCOM	Medical Command
MICO	Management Information Control Officer
MILCON	military construction
MILRP	Management Information Long Range Plan
MILSATCOM	Military Satellite Communications
MIL-STD	military standard
MODPLAN	modernization plan
MOP	memorandum of policy
MOU	memorandum of understanding
MSC	major subordinate command
MTMC	Military Traffic Management Command
MTOE	Modified Table of Organization and Equipment
MUSARC	Major US Army Reserve Commands
MWR	morale, welfare, and recreation
NAC	National Audiovisual Center
NAF	nonappropriated fund
NAFI	nonappropriated fund instrumentality
NARA	National Archives and Records Administration
NATO	North Atlantic Treaty Organization
NCA	National Command Authority
NCR	National Capital Region
NCS	National Communications System
NCTA	National Cable Television Association
NDI	nondevelopmental item
NFIP	National Foreign Intelligence Program
NGB	National Guard Bureau
NMCC	National Military Command Center
NMPS	Navy Motion Picture Service

NSA	National Security Agency
NTIA	National Telecommunications and Information Administration
O&M	operations and maintenance
OCE	Office of the Chief of Engineers
OCONUS	outside of the continental United States
OCSA	Office of the Chief of Staff of the Army
OF	official forms
OFPP	Office of Federal Procurement Policy
OJCS	Organization of the Joint Chiefs of Staff
OMA	operations and maintenance, Army
OMB	Office of Management and Budget
OPA	other procurement, Army
OPCON	operational control
OPSEC	operations security
OSA	Office of the Secretary of the Army
OSD	Office of the Secretary of Defense
OSE	open systems environment
OSID	Operations and Systems Integration Division
OT	operational test
OTEA	United States Army Operational Test and Evaluation Agency
PABX	Private Automatic Branch Exchange
PAN	production approval number
PARR	Program Analysis Resource Review
PBC	Program Budget Committee
PBG	Program Budget Guidance
PBX	Private Branch Exchange
PC	end-user microcomputer (personal computer)
PDIP	Program Development Increment Package
PEO	Program Executive Officers
PIN	production identification number
PLA	plain language address
PM	program manager
POM	program objective memorandum
PPBES	Planning, Programming, Budgeting, and Execution System
PSYOPS	psychological operations
QPL	qualified producers list
RBECS	revised battlefield electronics CEOI system
RCS	requirements control symbol
RDA	research, development, and acquisition
RDAP	Research Development and Acquisition Plan
RDG	random data generator
RDO	Regional Defense Organization
RDT&E	research, development, test, and evaluation

RPPO	regional printing procurement office
RS	requirements statement
RSI	rationalization, standardization, and interoperability
SA	Secretary of the Army
SB	supply bulletin
SC	specialty code
SCI	sensitive compartmented information
SDP	Special Documentation Project
SECORD	secure cord switchboard
SELCOM	Select Committee
SES	Senior Executive Service
SF	standard form
SI	special intelligence
SIDPERS	Standard Installation/Division Personnel System
SIGINT	signal intelligence
SIGSEC	signal security
SOFA	Status of Forces Agreement
SOI	Signal Operating Instructions
SOP	standard operating procedures
SORTS	Status of Resources and Training System
SPECAT	special category
SQL	structured query language
STAMIS	Standard Army Management Information System
STANAG	Standardization Agreement
STANFINS	Standard Financial System
STARC	State Area Command
STU-III	Secure Telephone Unit, Type III
SVS	secure voice system
TAA	total Army analysis
TAADS	The Army Authorized Document System
TACCS	Tactical Army Combat Service Support (CSS) Computer System (a CCS2)
TAFIM	technical architecture framework for information management
TAMMIS	Theater Army Medical Management Information System
TAP	The Army Plan
T-ASA	Television-Audio Support Activity
TB	technical bulletin
TCC	telecommunications center
TCC(A)	Theater Communication Command (Army)
TDA	Tables of Distribution and Allowances
TELEX	telephone exchangeTMtechnical manual
TMDE	Test, Measurement, and Diagnostic Equipment
TOE	Tables of Organization and Equipment
TRADOC	U.S. Army Training and Doctrine Command

TRI-TAC	Joint Tactical Communications Program
TSC	Training Support Center
TSO	Telephone Service Officers
UIC	unit identification code
USAISC	United States Army Information Systems Command
USAISEC	United States Army Information Systems Engineering Command
USAISAA	United States Army Information Systems Selection and Acquisition Activity
USAPPC	United States Army Publications and Printing Command
USAR	United States Army Reserve
USARC	United States Army Reserve Command
USAREUR	United States Army Europe and Seventh Army
USAVIC	United States Army Visual Information Center
USC	United States Code
USPFO	United States Property and Fiscal Office
VI	visual information
VIDP	Visual Information Documentation Program
VIRIN	visual information record identification number
VISC	Visual Information Support Center
VISPArmy	Visual Information Systems Program
VTC	video teleconferencing
WATS	Wide Area Telephone Service
WIN	Worldwide Military Command and Control System Intercomputer Network
WIS	Worldwide Military Command and control System Information System
WSMR	White Sands Missile Range
WWMCCS	Worldwide Military Command and Control System

INITIAL DISTRIBUTION LIST

1.	Defense Technical Information Center	2
	8725 John J. Kingman Road, STE 0944	
	Fort Belvoir, Virginia, 22060-6218	
2.	Dudley Knox Library	2
	Naval Postgraduate School	
	411 Dyer Road	
	Monterey, California 93943-5101	
3.	Professor Donald van Z. Wadsworth EC/Wa	1
	Naval Postgraduate School	
	Department of Electrical and Computer Engineering	
	Monterey, California 93943-5101	
4.	Major John H. Gibson CC/Gj	1
	Naval Postgraduate School	
	Department of Joint C ⁴ I	
	Monterey, California 93943-5101	
5.	Professor Dan C. Boger CC/Bo	1
	Naval Postgraduate School	
	Department of Joint C ⁴ I	
	Monterey, California 93943-5101	
6.	Major Mark A. Huron	1
	8502 Slimwood Drive	
	San Antonio, Texas 78240	